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the small systems journal

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WORD
PLAN
January
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Sales
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Material
COMMAND: Alpha Blank Copy Delete Edit Format Goto Sort
Quit Insert Lock Move Name Options Print
Help Xternal Value Window Transfer
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LtGray
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CHART
Heuristic reasoning is reasoning not regarded as final and strict but as provisional and plausible only, whose purpose is to discover the solution of the present problem.
ROBERT TINNEY
LINE INS
LINE DEL
ENTER

Easy Software

Inside Apple

Vol. 1, No. 4

A dot matrix printer that will improve your image.

Meet the Apple® Imagewriter, the newest dot matrix printer for your Apple Personal Computer.

And with all that it has going for it, just maybe the best dot matrix printer on the market.

Take legibility, for instance.

The Imagewriter crams 140 x 160 dots into each square inch. So you get text that's highly readable and high resolution graphics, besides.

And is it fast.

The Imagewriter cruises at an unbelievable 120 characters per second. And that's just in the text mode. It's even faster printing graphics. 180 characters per second, to be exact.

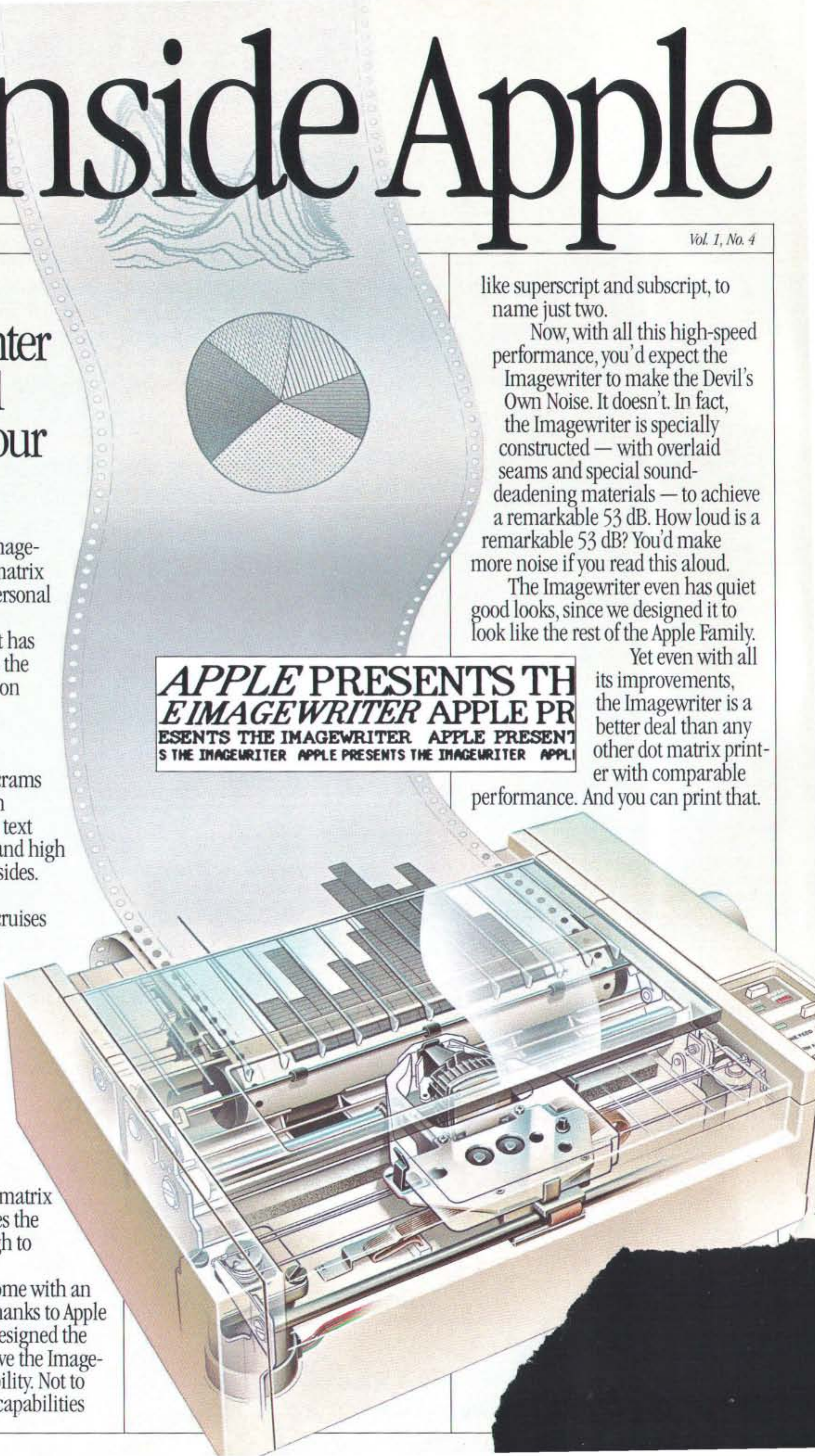
What's more, the graphics dump is up to 60% faster than other comparably priced dot matrix printers. And that makes the Imagewriter fast enough to handle the Lisa.™

Yet it's just as at home with an Apple III or Apple IIe. Thanks to Apple software experts who designed the control electronics to give the Imagewriter perfect compatibility. Not to mention some special capabilities like superscript and subscript, to name just two.

Now, with all this high-speed performance, you'd expect the Imagewriter to make the Devil's Own Noise. It doesn't. In fact, the Imagewriter is specially constructed — with overlaid seams and special sound-deadening materials — to achieve a remarkable 53 dB. How loud is a remarkable 53 dB? You'd make more noise if you read this aloud.

The Imagewriter even has quiet good looks, since we designed it to look like the rest of the Apple Family.

Yet even with all its improvements, the Imagewriter is a better deal than any other dot matrix printer with comparable performance. And you can print that.



APPLE PRESENTS TH
EIMAGEWRITER APPLE PR
ESENTS THE IMAGEWRITER APPLE PRESENT
S THE IMAGEWRITER APPLE PRESENTS THE IMAGEWRITER APPL

Charge!

Go out there and get the Apple Personal Computer System you really want. Now. Without laying out your extra cash. Without tying up your other lines of credit. With the Apple Card. The only consumer credit card reserved exclusively for the purchase of Apple Computers, peripherals and software.

Like all our products, it works simply:

Fill out an application (short, to the point and annotated in English) at an authorized Apple dealer honoring the Card. Your salesperson will call in the application and in most cases get an approval for you right on the spot.

You can then take your Apple system home. You don't even have to wait for the Card; we'll mail it out to you. And by the time you get it, you'll probably be well into doing whatever you bought your Apple system to do.

There is no annual fee for the Card, although a couple of restrictions do apply. The first purchase must include an Apple Personal Computer and you have to put 10% down. And subsequent purchases need to be at least $100 if made with the Card. Oh, yes — you'll also have a credit limit.

When you use the Apple Card to make additional purchases, all you
o is show the Card and sign
. As long as it's within
imit, of course. Our
ttle nervous when
or half their inven-
nd.

You'll also receive monthly statements that include the latest purchases, credit available, and the minimum payment due. You'll also be happy to know Apple Card credit terms are affordable and the payments can be spread out. It's all spelled out for you at the time your Card is approved.

So stop by a participating authorized Apple dealer and get an Apple Card. Just think of it as credit where credit is due.

Give your floppy disks the boot.

We call it the "floppy disk shuffle." It happens when you have two or more software programs on floppies and you need to work with both. What do you do? You put one disk in, boot it, do your work, take it out, put the other disk in, boot it, do your work — you get the idea.

Well, you can stop shuffling any time now.

Thanks to a unique new software program called Catalyst™ from Quark, Inc. Specially designed for your Apple III and ProFile™ hard disk.

Catalyst allows you to take a wide variety of software programs and store them on your ProFile. Once they're on your ProFile, you just select the program you want from the Catalyst menu that appears on your monitor — then Catalyst does the rest. You'll never have to boot those programs again.

What kinds of programs will work with ProFile and Catalyst? Almost anything written for the Apple III including copy-protected programs like VisiCalc,® Quick File™ and Apple Writer III. Or languages like Pascal, BASIC, or COBOL.

And once you've loaded these programs into your ProFile, the only diskette you may ever need is the Catalyst.

So if you have an Apple III and a ProFile and more floppies than you care to flip through, get yourself a Catalyst. And boot those disks for good.

Ave., Cupertino, CA 95014. For the authorized Apple dealer nearest you, call **(800) 538-9696.** *In Canada, call* **(800) 268-7796** *or* **(800) 268-7637.** *© 1983 Apple Computer Inc.*

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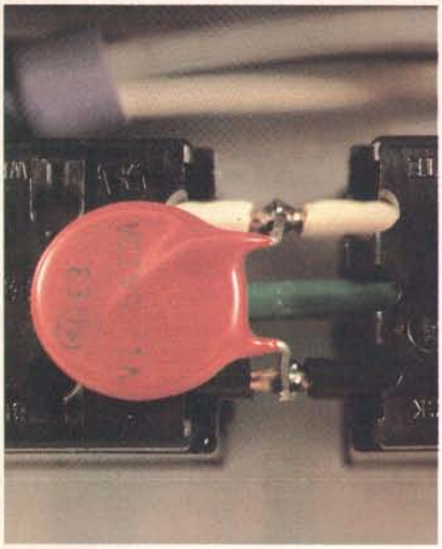
Circle 27 on inquiry card.

In The Queue

BYTE Volume 8, Number 12



Page 36

Page 48

```
                <<< TASK BUILDING >>>
To display the  | For statement help: type KEYWORD and ^W | To Use this task
menu/task names | For template  help: type KEYWORD and ^T | (and Build):  ^B
in this tree and| ASK      ELSE       MOUNT    REPEAT     |
for special     | CHECK    ENDIF      NOLIST   RESET      | To Quick
operations:  ^O | CLEAR    ENDREPEAT  PAUSE    RUN        |  commands:   ^Q
                | COPY     EXIT       PROMPT   SET        |
To Print this   | DELETE   IF         REMARK   SETSBCODE  | To exit and file
task:        ^P | DISPLAY  LIST       RENAME   STOPREPEAT | Kommands:    ^K
CHECK FOR MCCORDER.DTA
IF SBCODE = 1 THEN
   DISPLAY : YOU ARE STARTING A NEW ORDER FILE SO DATASTAR WILL ASK YOU"
   DISPLAY : FOR THE DISK DRIVE FOR THE .DTA AND .NDX FILES."
   PAUSE   : PLEASE ENTER "C" FOR BOTH. HIT RETURN TO CONTINUE."
ENDIF
RUN DATASTAR MCCORDER
```

Page 189

```
       PRODUCTIVITY ANALYSIS AND COMPARISON
RUN # 10 :  HOURS      UNITS    PRODUCTIVITY      COMPARISON TO LAST RUN
LINE #1     28.00  10,000.00          357.14      % CHANGE L 1    -18.30
LINE #2     35.00  12,500.00          357.14      % CHANGE L 2      0.00
LINE #3     32.00   9,500.00          296.88      % CHANGE L 3    -21.20
LINE #4     24.00   9,600.00          400.00      % CHANGE L 4     32.43
                                                  AVG % CHANGE      0.24
TOTAL      119.00  41,600.00          349.58      TOT % CHANGE      0.97

               HIGH         LOW    STND. DEV      AVG PROD LAST 10 RUNS
LINE #1      462.00      312.40        13.76      LINE #1         387.40
LINE #2      430.15      290.00         3.65      LINE #2         412.85
LINE #3      415.00      296.88        10.94      LINE #3         358.43
LINE #4      410.02      354.42         5.11      LINE #4         386.43
Command list 2:  Border [illegible] Colnumbers Graphics Lock Rownumbers Sort
                 Textformat Unlock Valueformat Width
Worksheet: a1 Location: r5c2 Window: 01 (resident) CREATE MODE
```

Page 199

Columns

36 Keep Power-Line Pollution Out of Your Computer by Steve Ciarcia / When lightning struck his home and did $3000 worth of damage, Ciarcia decided to strike back with this month's Circuit Cellar project.

48 BYTE West Coast: Microsoft Windows by Phil Lemmons / Microsoft Windows lets you test the effectiveness of the desktop metaphor and the mouse.

59 User's Column: Buddy, Can You Spare a Door Latch? by Jerry Pournelle / What to do when your disk-drive door is on the fritz and other comedies of errors at Chaos Manor.

Themes

100 Easy Software by Phil Lemmons / Making software easy to use is simpler to say than to do. This month's theme articles explore a variety of approaches to user-interface technology and sample programmers' attempts at making software do more with less effort.

103 An Introduction to Integrated Software by Dash Chang / Concurrency, shared technology, and functional integration are three ways of integrating software.

113 Presentation and Form in User-Interface Architecture by John M. Carroll / With the help of a test group, the author and his colleagues developed an interface that facilitates ease of use and ease of learning.

127 Why Is Software So Hard to Use? by Sam Edwards / Chances are it's the software's fault and not yours.

143 Walt Disney and User-Oriented Software by Paul Heckel / Software designers can learn a few things from Mickey Mouse about communicating ideas.

155 Making Life Easier for Professional and Novice Programmers by Andy Pope, Geoff Kates, and Dan Fineberg / A debugger that "animates" the program's source code on the screen and lets the programmer engage in what-if analysis to find logic errors can drastically reduce debugging time.

161 Simplify, Simplify, Simplify by Martin Dean / In an attempt to design a truly easy-to-use database manager, the author disregarded nifty features and clever, complex functions in favor of starting fresh.

177 Integrating Voice in the Office World by Robert T. Nicholson / The ability to record a spoken message and store it digitally on a computer system makes possible a whole new range of applications.

189 The Starburst User Interface by Steven Vandor / This software package helps you build efficient, powerful menus.

199 The Complete Information-Management System by Michael J. Brown / The ideal information-management package maximizes hardware attributes and minimizes user interaction.

210 The Allegory of Software by Tom Houston / Tired of the same old desktop metaphor? Maybe the digital kitchen is more up your alley.

218 The New Interface Technology by Robert W. Warfield and George M. White / A close-up look at mice, windows, and other software and hardware developments that make computer systems easier to use.

234 Trackball Interfacing Techniques for Microprocessors by Edward W. Andrews / This simple hardware/software interface device is easy to adapt to your interactive personal computer applications.

247 The User Interface: Two Approaches by Martin Herbach, Richard Katz, and Joseph Landau / The philosophical vs. the pragmatic approach to the construction of an efficient user interface.

263 The Future of Metaphor in Man-Computer Systems by Chuck Clanton / Learnability is the single most important concern in user-interface design.

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Reviews

282 Reviewer's Notebook by Rich Malloy / BYTE's product-review editor comments on products slated for review.

286 The Texas Instruments Professional Computer by Mark Haas / Based on Intel's 8088 16-bit chip, TI's Professional Computer is the Data Systems Group's entry into the personal computer arena.

329 The ATR8000 by Dave Small and Sandy Small / With SWP's Z80 computer, Atari users can run CP/M-based programs.

343 The Hercules Graphics Card by Tom Wadlow / If you want crisp, attractive text as well as graphics on the IBM PC, the Hercules Graphics Card is for you.

360 The Wang Professional Computer by Elaine Long / This 16-bit microcomputer provides an easy-to-use word-processing program with sophisticated features.

372 In Search of the Most Amazing Thing by Elaine Holden / This adventure game for the IBM PC, Apple, Atari, and Commodore 64 offers you an entire world to explore in your quest for a hidden object.

Features

380 Color Graphics from Any Computer by Frederick B. Essig / How to make high-quality full-color graphics from your black-and-white monitor.

400 Mainframe to Micro: Adapting a Financial-Modeling Language by Greg Dunn / As the microcomputer moves into the office, software developers face new challenges in translating existing mainframe software to the microcomputer environment.

417 POKEing Around in the IBM PC, Part 2: Subroutines for the BIOS Interface and Screen-Display Disk Storage by Hugh R. Howson / In this final article, the author develops a general-purpose BIOS-interface subroutine that can transfer parameters from a BASIC program to the BIOS and can store BIOS results in memory.

443 The CMOS 6502 by Steven Hendrix / Rockwell's CMOS version of the 6502 microprocessor fills a number of gaps in the standard 6502's instruction set and offers low power-consumption advantages.

457 A Tiger Meets a Dragon by Dan Rollins / A look at dragon-curve designs and how to print them on an IDS Paper Tiger printer.

481 A Computer-Algebra-Based Calculating System by Stuart Edwards / By performing automatic unit conversion, this super-calculator saves time and effort and prevents common errors.

519 The User Looks at Books by Jerry Pournelle / Jerry takes time out to round up the best and worst books on CP/M, Pascal, C, and Ada.

Nucleus

4 Editorial: Christmas in Chapter XI
7 MICROBYTES
11 Letters
358, 594 BYTE's Bits: IBM Announces the PCjr; Two New Office Products from IBM
499 User to User
530 Software Received
546 Clubs and Newsletters
550 Books Received
554 Ask BYTE
568 Event Queue
574 What's New?
596, 598 Book Reviews: Electronically Speaking: Computer Speech Generation; Mastering CP/M
653 Unclassified Ads
654 BYTE's Ongoing Monitor Box, BOMB Results
655 Reader Service

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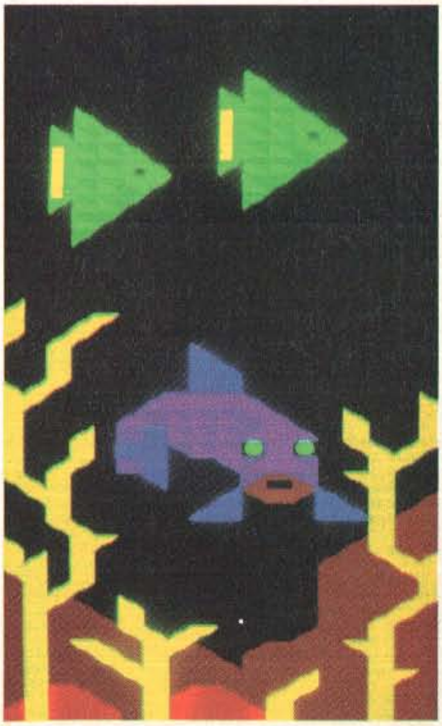
Page 286

Page 372



Page 380

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Editorial

Christmas in Chapter XI

Personal computers are priced within the reach of many potential buyers looking to reward themselves or their companies with some special indulgence at this time of year. If you've been thinking about buying a machine, you've probably been weighing the performance specifications of several vendor offerings. But have you included in your list of questions about hardware and software one that could prevent you from making a selection you'll later regret: Will the hardware manufacturer still be in business a year from now?

You know that software availability usually lags behind hardware introduction, sometimes by months, so you'll want to know that a new machine can run most of your existing software. And you'll certainly want assurance about who will repair a new computer and how quickly. But in the midst of mutterings about a pending shakeout in the personal computer business and hard evidence of company failures, how can you assure yourself about the very viability of a vendor?

One attribute of a "survivor" company is solid financing, especially if the company is a young one. The dollar drain triggered by graduation from the start-up phase to volume production has ruined many a fast-growing new company that found itself unable to deliver finished goods because of a cash shortage that resulted in an inability to pay for parts.

Innovative start-ups sometimes get distracted by an infatuation with technology, regardless of the technology's market appeal. Such a situation often leads to the development of a computer that has esoteric appeal but that will not attract enough software development to assure market acceptance for the product and company.

The breadth of its product line is another characteristic of a successful computer vendor, whether the company is a start-up or a proven survivor. Firms that hitch their fortunes to narrow niches—those that serve only the portable computer market, for example—face more risks than those whose product lines have entries in several niches at several price points.

Buyers should consider other important attributes of successful computer companies as well, including the company's approach to mass distribution, which often assures quick delivery and repair, when needed. But perhaps the most important question that should be answered is whether the company whose product you're considering is truly a computer company. If nobody in top management in the company has sound computer hardware or software credentials, the company may be a conglomerate or a semiconductor manufacturer whose long-term commitment to the computer business is questionable.

Several years ago, the then Philco-Ford Corporation and GTE Sylvania, both broadly recognized as reputable manufacturers of consumer and military electronic products, were also in the merchant semiconductor market. They aren't today, probably because when their commercial semiconductor operations ran into financial difficulties, as any business will, nobody in top management came from semiconductor roots; there wasn't any senior "sponsor" to sustain a commitment to that business.

So read all you can about the companies whose products are on your list, and ask a lot of questions. Otherwise, you could end up with a computer from a supplier who spends this or next Christmas in Chapter XI bankruptcy proceedings.

—Lawrence J. Curran, Editor in Chief

How Cromemco plugs you into the state of the art.

Cromemco offers you the most complete line of S-100 boards and peripherals in the business. These boards use the new IEEE-696 state-of-the-art standard. One-stop shopping can satisfy your design needs the easy way.

You can build one system, or a hundred, exactly the way you want, and upgrade existing systems with a simple board swap or addition. And since we design our own boards for our own systems, we always take advantage of the latest developments in IC technology.

68000 microprocessor performance. Cromemco's Dual Processor Unit gives you the best of both worlds: the 68000 and the Z-80A microprocessors on the same board. It's the easiest way to move into 68000 performance and still use your existing 8-bit software. Or use Cromemco's Z-80A CPU board or our Z-80A-based single board computer.

For selection, Cromemco can't be matched. From the well-known SDI High Resolution Color Graphics board to the new 512MSU, 512K byte RAM board. From our highly reliable Local Area Network interface (C-NET) to our wide variety of general purpose interface boards. And you can put them in one of our 8-, 12-, or 21-slot card cages with our 12 amp PS-8 power supply to get your system into operation fast.

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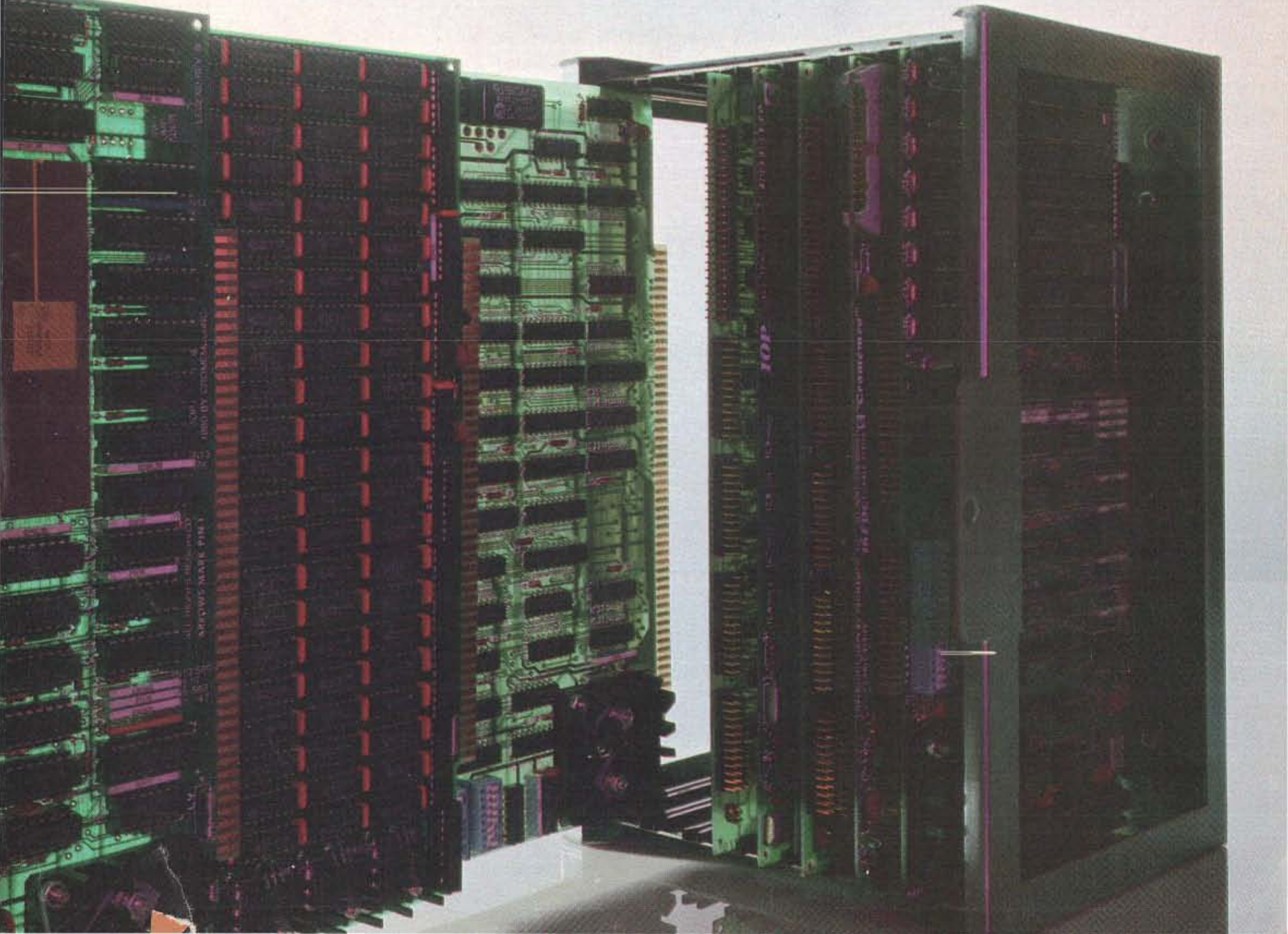

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$1995 Complete

The IBM® Compatible Computer

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Using a unique dual processor technology, the Chameleon by SEEQUA is both IBM-PC compatible and CP/M-80™ compatible providing the largest software support available.

TWICE THE MEMORY

128K bytes RAM are standard, internally expandable to 256K. And 320K formatted disk storage is included.

SOFTWARE INCLUDED

Your computer is delivered with SEEQUA's MS-DOS, compatible with the IBM standard 16 bit PC-DOS operating system. It includes Perfect Writer for word processing and Perfect Calc for financial analysis. And it has MBasic to let you write your own routines. Chameleon comes standard with 640 x 200 resolution black and white graphics and 320 x 200 resolution color graphics.

EXPANDABLE

Chameleon has both serial and parallel ports standard. You can add an additional serial port or the IEEE-488 port. You can even use IBM PC compatible add-on boards in our optional expansion interface package.

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MICROBYTES

Staff-written highlights of late developments in the microcomputer industry.

IBM SHOWS TWO VERSIONS OF THE PCjr, PROMISES DELIVERY IN '84

IBM announced the PCjr, its long-awaited home computer that was code-named "Peanut." This new machine features an 8088 microprocessor, 64K bytes of RAM, and a detached keyboard linked via infrared light. The new machine also features two cartridge slots for game cartridges, a joystick, a light pen, and serial connectors. Two configurations will be offered. The "Entry" system, which has no disk drive, will sell for $669. The "Enhanced" system, which features a 5¼-inch half-height floppy-disk drive (360K bytes) and 128K bytes of RAM, will cost $1269. The Enhanced system will run many, but not all, IBM PC programs. Deliveries of these machines should begin in the first quarter of 1984. For more details, see page 358.

IBM ALSO ANNOUNCES A COLOR PRINTER

In what seemed to be a flurry of new product announcements, IBM added yet one more: the IBM Personal Computer Color Printer. This new printer features three printing modes: data-processing quality (200 characters per second), text quality (110–150 char/sec), and near-letter-quality (30–40 char/sec). With a "Process" ribbon, which has four bands of color (black, magenta, cyan, and yellow), the printer can print eight colors. The printer also supports proportional spacing and bit-mapped graphics and is compatible with the IBM Graphics Printer.

TWO CHIP MAKERS ANNOUNCE NEW VERSIONS OF MICROPROCESSORS

National Semiconductor, Santa Clara, CA, is shipping samples of its 32032 microprocessor, with full production of the CMOS chip scheduled for April 1984. The NS32032 shares the same 32-bit internal architecture as the NS08032 and NS16032 (the 8- and 16-bit data-bus versions), but its 32-bit data bus allows it to execute more than 1 million instructions per second. While the NS32032 now sells for $220 in quantity, National Semiconductor expects the price to drop to between $20 and $60 by 1985.

The Western Design Center, Mesa, AZ, is preparing to begin test production of the 65816, a 16-bit CMOS version of the popular 6502 microprocessor used in Apple, Commodore, and Atari computers. The processor, which uses an 8-bit data bus and allows 24-bit addressing (to address up to 16 megabytes of RAM), will come in two versions, one of which will be pin-compatible with the existing 6502 so that it can be used in the same equipment, according to the designer. The Western Design Center plans to begin full production in the first half of 1984, with a price of about $20 per chip. Once that chip is in production, WDC also hopes to prepare a 32-bit version with a 16-bit data bus.

Hayden Software, Lowell, MA, is preparing an assembler and a Pascal compiler for the 65816, to be available in early 1984.

WANG INTRODUCES DIGITIZING IMAGE SCANNER FOR THE PROFESSIONAL COMPUTER

Wang Laboratories, Lowell, MA, has given its Professional Computer "eyes" in the form of a desktop scanner that digitizes images at a resolution of 200 dots per inch (1728 by 2200 pixels for the maximum 11- by 14-inch image). Images can be enlarged, reduced, or rotated 90 degrees and merged with word-processing text. The complete Professional Image Computer, with a 10-megabyte hard disk (to store about 100 images), monitor, thermal printer, and image scanner, sells for $14,965.

CALIFORNIA COMPANY DEVELOPING GALLIUM ARSENIDE COMPUTER CIRCUITS

Gigabit Logic Inc., Newbury Park, CA, expects to have GaAs semiconductor devices ready for customer sampling by February or March. Gallium arsenide is superior to silicon for high-speed logic and memory components because it permits greater mobility for electrons moving through the semiconductor.

Gigabit Logic says GaAs RAM devices could have access times of 1 nanosecond, compared to 5 to 7 nanoseconds for the fastest silicon RAMs. Logic circuits made with GaAs are expected to operate 3 to 10 times faster than today's fastest silicon logic. Gigabit's first products will include various small- and medium-scale ICs; the first 1-nanosecond RAMs could be available for sampling in the first quarter of 1985. GaAs circuits will be priced substantially higher than similarly sized silicon logic and memory devices, but computer manufacturers may be willing to pay an initial premium to get the higher speed offered. One of the first applications of GaAs devices in small computers may be as display generators, offering high-speed, high-resolution graphics.

SHUGART UNVEILS A $6000 OPTICAL-DISK DRIVE WITH 1 GIGABYTE OF STORAGE

Shugart Corp., Sunnyvale, CA, has announced a 1-gigabyte (1-billion character) laser-based optical-disk drive with a volume price of $6000 each (plus $1500 for an SCSI controller). The drive uses nonerasable 12-inch optical disks, which cost between $100 and $150 each. Shugart suggests that the first use of optical storage might be as a file server for networked personal computers. Shugart sells 3½-, 5¼-, and 8-inch disks to computer manufacturers and will target the optical drive to the same market.

NEW SOFTWARE INTRODUCED FOR IBM PERSONAL COMPUTER

Mosaic Software, Cambridge, MA, has announced Integrated Six, a $495 integrated-software package including spreadsheet, database-management, word-processing, graphics, communications, and terminal-emulation capabilities. . . .**Symmetric Software,** Newport Beach, CA, is offering Blue, a multiple-window color word processor for $150. . . .**Quicksoft,** Seattle, WA, sells PC-Write, a word-processing package, for $10. Quicksoft encourages users to copy the program but charges $75 to register the program. Registered users receive updates and bound documentation. . . .**Scientia Inc.,** Wellesley, MA, introduced Concept VP, a window-oriented operating environment for the IBM PC. The $350 program will enable users to switch between application programs using a mouse or cursor keys. . . .**Excalibur Technologies Corp.,** Albuquerque, NM, is now selling IBM PC versions of Savvy, its natural-language database-management system previously available only for the Apple II Plus and IIe. Three versions are available, ranging from $349 to $950. . . .**Concentric Data Systems,** Westborough, MA, plans to offer an easy-to-use database-management program for the IBM PC. The Concentric Information Processor will sell for $395.

NANOBYTES

IBM has announced two new versions of the Personal Computer: the XT/370 and the 3270 PC. See page 594 for details. . . .**Apple Computer,** Cupertino, CA, has announced a $325 database-management program for the Apple III. Apple has also developed a programmer's toolkit for the Lisa computer. Lisa Port provides the complicated software needed to manage the mouse- and window-based environment, thus enabling most software developers to run their applications on the Lisa. . . .**Compuserve,** Columbus, OH, will test the effects of advertisements and direct-marketing offers on its information service beginning in January. One- or two-line spot ads will be used on menu pages, and catalog and product information will also be available during the four-month pilot program. . . . **Hitachi Ltd.,** Tokyo, has developed an 8-inch floppy-disk drive using a special disk with an unformatted capacity of 9.6 megabytes. Samples of the drive will be available next month for about $1075. . . . **Microcom Inc.,** Norwood, MA, has introduced ERA-2, a communications system for the IBM PC and the Apple IIe. Including software and a 1200-bps modem, ERA-2 will sell for $429. . . .**Intel Corp.,** Santa Clara, CA, has announced a nonvolatile 4K-byte RAM chip made by backing up 4K bytes of RAM (with an access time of 200 nanoseconds) with a 4K-byte EEPROM. The 2004 nonvolatile RAM will be available in early 1984 at a price of $25.10 each in 100-unit quantities. . . .**Texas Instruments,** Lubbock, TX, cancelled plans to introduce the 99/8 home computer this fall. . . .**Compaq Computer Corp.,** Houston, TX, is shipping the Compaq Plus, a hard-disk version of its IBM PC-compatible portable computer. The $4995 machine includes a 3½-inch hard disk mounted with a shock-isolation system. . . .**Seagate Technology,** Scotts Valley, CA, is shipping samples of a 12-megabyte half-height 5¼-inch hard-disk drive. The ST212 is designed for portable computer applications and will sell for $690 in 1000-unit quantities. . . .**Enter Computer,** San Diego, CA, has introduced a six-pen plotter, the Sweet Pea Model 600, for $1075. . . .**Bridge Communications,** Cupertino, CA, has announced Communications Server/100, which connects 10 RS-232C devices to Ethernet for as little as $3900. . . .**Micro Office Systems Technology,** Fairfield, CT, has introduced the Road Runner, a 5-pound notebook-size portable computer with cartridge-based software and memory and an 8-line by 80-character LCD built into its flip-up cover. The Z80-based system with 64K bytes of RAM, bundled software, a serial port, and a built-in 300-bps modem sells for $1895. . . .**Compugraphic Corp.,** Wilmington, MA, has introduced the Personal Composition System, which links the Apple Lisa to a Compugraphic typesetter. The system, which is priced from $26,895 including the Lisa and typesetter, was designed for office users who want typeset-quality computer output.

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        STOCKS/WARRANTS - COMPOSITE/OTC

Symbol                       DJ            T
Quantity                    100          100
Purch. Price          45           61
Date                  01/07/02     06/14/83
Bid/Close             51           63  3/4
Ask/Open              52  3/4      64
Yield/High            52  3/4      64  1/2
Low                   51  7/8      63  1/2
Last                  52           63  3/4
Change                 1
Vol (100's)                 293        16342
Current Price         52           63  3/4
Current Value         $5,200.00    $6,375.00
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With all the clamor about personal computers, a fundamental fact is often overlooked: some simply *work* better than others.

Consider the COMPAQ Portable.

A computer will make you more productive. A computer will make you more efficient. You hear it everywhere. But you don't hear about which computer actually *works* best.

A computer isn't magic. It's a tool. And just like other tools, some computers work better than others.

The COMPAQ™ Portable is a combination of 20th-century electronics and 19th-century pragmatism. It simply does personal computing better. Here's why.

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You don't do all your thinking in one place. Why have a computer that stays in one place?

The COMPAQ Portable has all the capabilities of a large desktop computer. But now those capabilities can go where you go.

You can move it from office to office to share its resources. You can move it into the conference room to answer questions when and where they come up.

With the COMPAQ Portable, you can be as productive in your hotel room or your lake house as in your own office. It's a reliable companion on a business trip. It's a powerful sales aid in your customer's office.

What's more productive than a computer? A computer that works for you in more places.

Works with the greatest number of programs

The most important consideration when you choose a computer is "what programs will it run?" And that's one more reason for choosing the COMPAQ Portable.

The COMPAQ Portable was designed to fit under a standard airline seat so you can take it on business trips.

The unique aluminum frame of the COMPAQ Portable has cross-members that strengthen it front-to-back, side-to-side, and top-to-bottom. It's a design practice commonly used in race cars.

The COMPAQ Portable runs more programs than any other portable. In fact, it runs more than most non-portables. That's because it runs all the popular programs written for the IBM® Personal Computer. There are hundreds of them. They are available in computer stores all over the country, and they run without any modification, right off the shelf.

Imagine the power of a *portable* word processor. There are dozens of different word processing programs available for the COMPAQ Portable.

Planning, problem-solving, and "what-ifs" are a cinch with a variety of popular electronic spreadsheet programs. The COMPAQ Portable runs them all.

There are accounting programs for anything from computerizing your family budget to full-scale professional management of payables, receivables, inventory, and payroll for your company.

There are programs for making charts and programs for communicating with other computers. Or if you want something really specialized, there are even program languages for writing your *own* programs.

So, you get portability and you don't give up problem-solving power. The combination adds up to the most useful personal computer on the market today.

Works better because it's easy to read

The display screen of the COMPAQ Portable measures nine inches diagonally. It shows a full "page width" of 80 characters on a line so tasks like word processing are easier. And those characters are big enough to read even if you're leaning back in your chair.

The display shows both high-resolution graphics and easy-to-read, upper- and lowercase characters. One screen for all the information. With some personal computers, including the IBM, you can have either the graphics or the legible characters, but you can't have both unless you buy two different displays.

There are hundreds of useful programs for the COMPAQ Portable because it runs all the popular programs written for the IBM.

Incidentally, computer prices are often quoted without a display. The display of the COMPAQ Portable is built in, of course.

Add-on options make it work the way you work

Inside the COMPAQ Portable are three open slots. Electronic devices called expansion boards fit those slots and give the COMPAQ Portable new powers.

Just like the programs, expansion boards designed for the IBM work with the COMPAQ Portable, so there are dozens available right now. With them, you can make your personal computer more personal.

Want to check a stock price? Or look up something in The New York Times Information Service? One expansion board enables the COMPAQ Portable to handle those communications over ordinary phone lines.

Want to use your company's central computer files while you're on a trip? There are boards that allow the COMPAQ Portable to communicate with a variety of large mainframe computers.

Other boards let you hook up controllers for computer games or increase memory capacity. Still others let you connect personal computers in a network so several people in your office can share the same information.

Inside the COMPAQ Portable are three slots for optional electronics that can add new capabilities. Most portables have none.

Works better because it's tough enough for the road

Portable doesn't just mean smaller. Portable means tough, too.

The COMPAQ Portable was built to withstand the hard knocks of constant travel. An aluminum frame within the case completely surrounds the computer's working components. Each disk drive is mounted in rubber shock absorbers instead of being bolted directly to the frame.

To test internal components, the COMPAQ Portable was subjected to impacts of 40 G's *while running a program*. After impacts on each side, there was no internal damage and the program was still running. Without error.

Computers are for getting rid of worries, not giving you new ones.

Designed to help you work better, too

The COMPAQ Portable was designed to *feel* good.

Specifications

Software
- ☐ Runs all the popular programs written for the IBM PC

Memory
- ☐ 128K bytes RAM
- ☐ Expandable to 640K bytes

Storage
- ☐ One 320K-byte minifloppy disk drive, second drive optional

Display
- ☐ 9-inch (diagonal) monochrome screen
- ☐ 25 lines by 80 characters
- ☐ Upper- and lowercase, high-resolution text characters
- ☐ High-resolution graphics

Expansion board slots
- ☐ Three IBM PC-compatible slots

Interfaces
- ☐ Parallel printer interface
- ☐ RGB color monitor interface
- ☐ Composite video monitor interface
- ☐ TV RF modulator interface
- ☐ Communications interface optional

Physical specifications
- ☐ Totally self-contained and portable
- ☐ 20"W × 8½"H × 16"D

The keyboard is detached so it can fit into your most comfortable working position.

The keyboard cable remains connected at all times. So you don't have to unpack it and hook it up every time you use your computer.

Because the display is built in, the COMPAQ Portable makes a neat, small package on your desk, instead of a big obstacle you have to talk around. The built-in display also avoids the usual cable clutter because there's no need for separate cables for the display.

The COMPAQ Portable even has an electronically synthesized sound to create the familiar keyclick of a typewriter. With a simple keyboard command you can adjust the volume to suit the level of background noise in your office.

The added usefulness is free

The COMPAQ Portable can do what desktop computers do and do it in more places. But it doesn't cost any more than an ordinary desktop.

In fact, it costs hundreds less than a comparably equipped IBM or Apple® III. The COMPAQ Portable comes standard with one disk drive and 128K bytes of memory, both of which are usually extra-cost options. A second disk drive and additional memory are available to make your COMPAQ Portable even more powerful.

The bottom line is this—you just can't buy a more practical, useful, productive computer. Before you decide on a computer, you owe it to yourself to compare the COMPAQ Portable.

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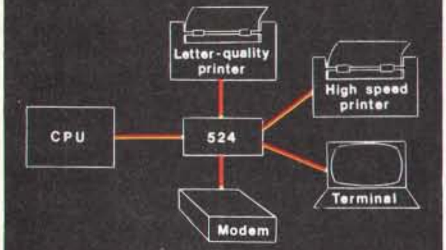

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Letters

Subtle Features of the HP-75

While I liked Rowland Archer's review of the HP-75 (September, page 178), I found that it hardly scratched the surface of this remarkable machine and did not address many of its strongest, albeit subtle, features.

Perhaps this machine's most attractive feature is its ability to enable a RAM-based BASIC program to interact with other RAM-based files and its ability to transform a text file to BASIC and vice versa. This may not sound like much, but it opens the door to many advanced applications. For example:

- A BASIC program can be written to take a FORTRAN source in a text file and "edit" it into BASIC under program control.
- A program generator for numerical-equation solving can be written in less than 3.5K bytes. Allowing unlimited length variables, it enables the user to specify only equations, rewriting them to the required BASIC syntax, determining I/O (input/output) variables, and automatically supplying all I/O and control statements.
- A friendly relational database allowing multicharacter field names and permitting complex Boolean inquiry expressions takes but 2.5K bytes.
- Artificial intelligence types take note: an HP-75 program can be made to edit itself (shades of LISP). A few BASIC statements are all it takes.

The multiple-file structure allows other seemingly impossible feats. A user can manually interrupt a running program, call another from the keyboard, then continue the first from where he or she left off—no loss of data, pending returns, etc.

The HP-75 operating system is beautifully integrated with the BASIC, and all catalog information is accessible, permitting BASIC to perform as a job control language. I wrote a full menu-driven operating system in 931 bytes.

The editor is very nice. The Fetch key performs a "find" function, a sorely missed feature on most other machines. Additionally, the keyboard is totally redefinable. Keys can be redefined as other letters, strings, commands, whatever.

The one-line display is not as bad as some would think, and an 80-column, 25-line video adapter is now available from Mountain Computer Corporation.

Lastly, the HP-75 is extremely fast for floating-point number crunching. While it is slow using an empty FOR/NEXT loop or prime-number program as a measure, it will easily outdistance an Apple, TRS-80, or TRS 80/M-100. The IBM is faster, but the IBM Personal Computer's transcendental functions are accurate to only 6.5 digits compared to the HP's 15 digits. The recently released Math ROM adds matrix operations, complex variable types, and root solvers (to name a few) to the language, giving the HP-75 the most convenient BASIC available for numerical work.

I am admittedly biased toward my HP-75 but I feel it has been overlooked by many, probably because of its form factor. It is not just another hand-held computer but a unique and powerful computer system, and it warrants greater attention from the technical press. The article in the September BYTE was a first step.

James A. Walters
4171 Antler Trail
Smyrna, GA 30080

I am a proud owner of an HP-75 portable computer and I think I know almost everything there is to know about this incredible machine.

Rowland Archer's review (September, page 178) describes the machine fairly well. But I think he should have done more research before attempting to review this product.

Archer says in his conclusion: "However, it does tie you to HP's devices, rather than letting you use devices that interface to standard serial or parallel ports such as modems."

This is false. I use my HP-75 with an Epson FX-80 printer with a parallel interface, and with a Muraphone 300-bps (bits per second) modem. This little machine can be used with almost any interface (serial, parallel, or HPIB bus). There are HP-IL interface converters on the market that enable you to use this computer with any other interface.

Walter Yadegar
POB 687
Skokie, IL 60076

Rowland Archer Jr. replies:

I am glad to hear that these interfaces are

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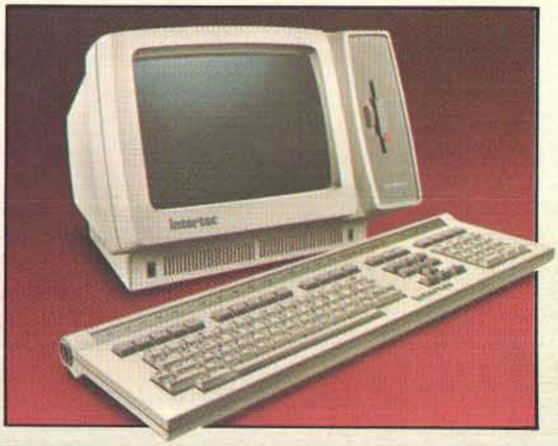

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available. None of the literature accompanying the review machine mentioned this capability, and I have never seen it advertised. Interested HP-75 owners should contact Mr. Yadegar or their HP dealer for details on availability and prices.

Poor Support from Epson Riles User

David Ramsey was much too lenient in his comments on Epson's poor support of the HX-20 ("Epson's HX-20 and Texas Instruments' CC-40," September, page 193.) Sure, the people at Epson hurt themselves by not taking advantage of their early lead in this market of the future, but they also hurt their early customers. (I am one of them, and not very happy about it!)

Consider the HX-20 from a customer's point of view—mine. In October 1982 I called Epson and asked if the HX-20 would support machine language. Sure, they said, so I bought a shiny new HX-20 (without the cassette drive or Skiwriter). The only documentation that came with the HX-20 was a skinny little "Operations Guide" that didn't help much. Two months later the BASIC manuals and a couple of Mickey Mouse (apologies to Walt Disney) software cassettes showed up, together with the extra-cost microcassette drive. The BASIC manuals describe the BASIC adequately, but for information on the machine language the manuals refer you to the *HX-20 Technical Reference Manual*. I promptly (in February 1983) ordered the manual. The dealer said he didn't have it yet, but promised it by April 15. That date came and went and still no manual. Ditto May 15, June 15, July 15, and August 15.

During this time, I sent numerous letters to Epson yielding prompt replies that said nothing about the *HX-20 Technical Reference Manual*, the promised display controller, disk drive, software, user group, or anything else that would have been useful.

Of course, the display controller will only be a 32-column, 16-line TV toy anyway, so I might as well write the whole thing off as a loss and start over. But let it be known that this buyer is more wary now. Next time the support comes first, then I put out the cash.

B. H. Geyer
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Liverpool, NY 13088

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QUV-T8 / Z ($124.95) Similar to QUV-T8/2T (with 40% faster Erase Time).

QUV-T8/2N ($68.95) Same as the QUV-T8/2T version without the timer and safety interlock switch.

QUV-T8/1 ($49.95) Economy model in a molded two part plastic case. Erases 15 EPROMS in 15 minutes.

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Starting FORTH as a Textbook

I have several disagreements with Thomas Clune's review (September, page 494) of *Starting FORTH* by Leo Brodie.

I used *Starting FORTH* when teaching a course in 1982. We found many of the pictures quite helpful. In particular, making people out of INTERPRET, WORD, EXECUTE, and the compiler provided students with memory "hooks" that made explanations easier.

It's true that Brodie covers all the built-in features of FORTH including the hard, subtle things. But it's these features that account for much of FORTH's power. Virtually all tutorials avoid serious discussion of things like CREATE DOES> leaving a misleading impression of the language. *Starting FORTH* worked well in my class; it needed little extra explanation compared to most texts I use. (I must admit that the students were already good programmers; Clune may be right about the effect of the latter part of the book on less experienced readers.)

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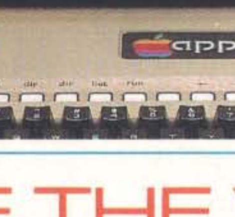

Photo of actual-size characters on Apple Monitor III.

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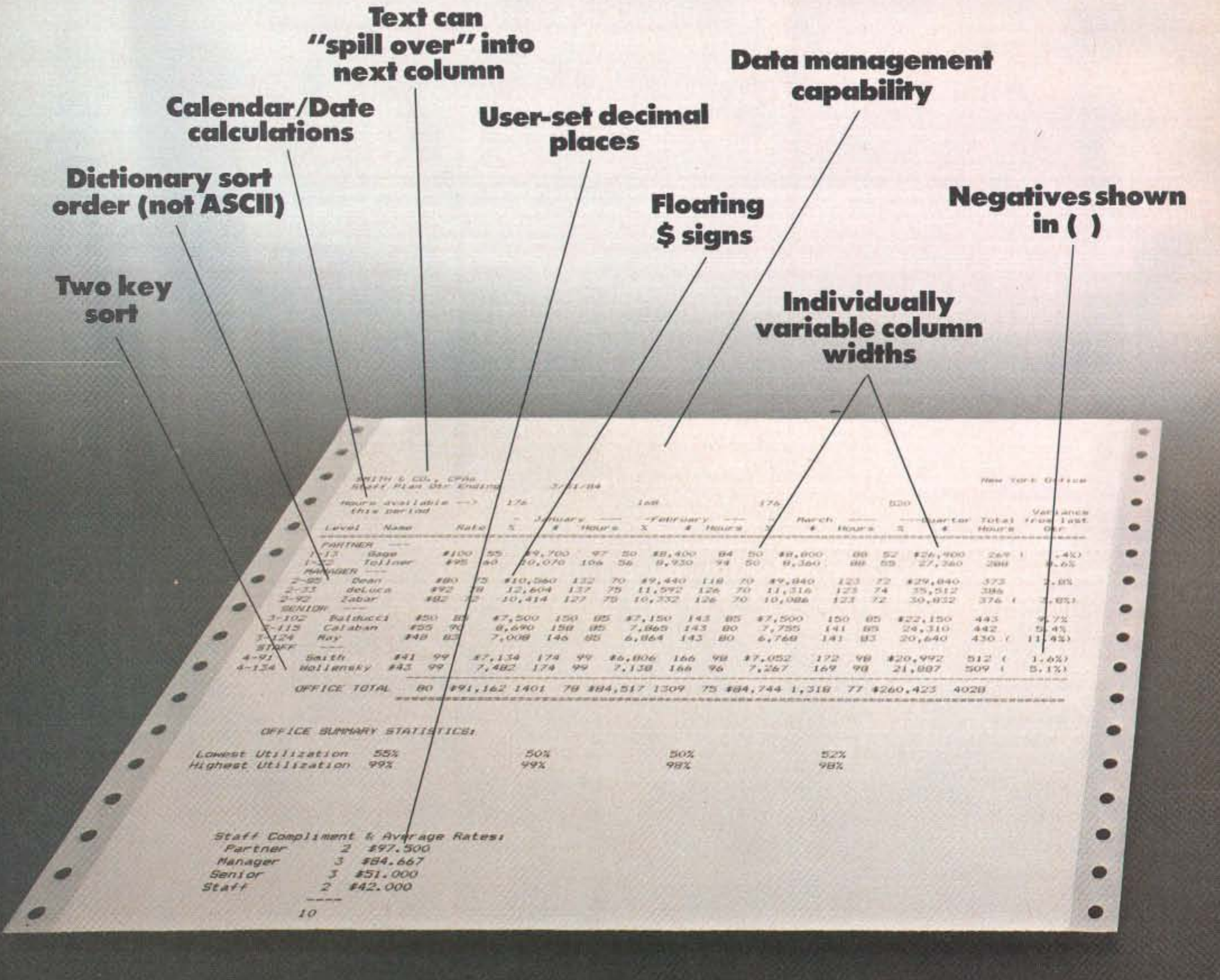
What we're really talking about here is useability. When you get right down to it, it's not any one big thing, but a combination of little things. Like the number of keystrokes it takes to get a job done. Or the effort it takes to switch from one function to another. Maybe a few keystrokes here and there doesn't seem like much of a difference. Or having to change disks to plot a graph. But when you multiply those little things by the thousands of times you do them, they make all the difference in the world.

Even the size of the spreadsheet is important. Some programs promise you a huge area to work with. Unfortunately, they can use so much of the computer's available memory just keeping track of all the blank cells that you're left with only a handful. But we've designed SuperCalc to give you the largest useable spreadsheet.

If you look at the printout below, you'll see a lot more examples of what we mean. And we think you'll realize why this is the most useable spreadsheet in the world.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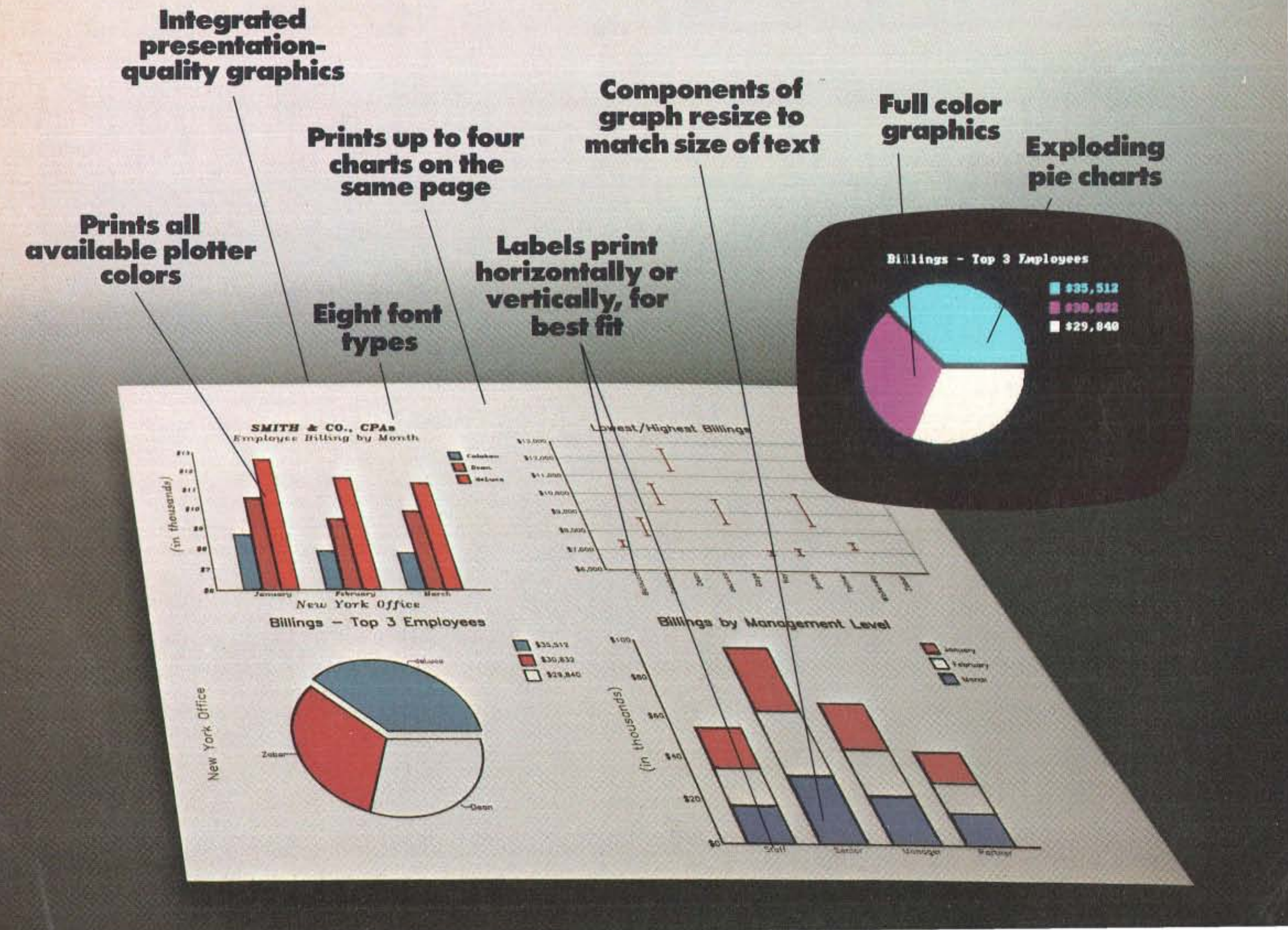
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Before teaching the course, I had considered writing my own book on FORTH, one that would explain the really subtle and powerful features of the basic system. After studying Brodie's text and teaching from it, I decided that that particular publishing niche is well filled already.

I do agree with Tom Clune on a couple of points: "...[*Starting FORTH*] desperately needs a real index. Nonetheless, if you want to learn FORTH, you will need this book."

Vernor Vinge
Associate Professor
Department of Math Sciences
San Diego State University
San Diego, CA 92182

Wrong Aliases

Having an interest in the use of Unix in the commercial marketplace, I read "The Unix Tutorial Part 2: Unix as an Applications-Programs Base" (September, page 257) with anticipation. Since David Fiedler's intended audience was apparently the Unix novice, I thought I had better point out a problem with his examples of renaming the "terse" command names.

While all of Mr. Fiedler's examples would work in most cases, he unfortunately decided to rename the "mv" and "cp" command. I use the term "command" rather than "commands" because they are one and the same program as in the "ln" command. This program knows which function it is to perform by the name used. If a name other than "cp," "mv," or "ln" is used, the program will default to the "cp" (copy) function. In this particular case, the user would not achieve the desired result either by renaming the command or by linking the desired name.

The alternative solutions of using the "alias" function for the UCB C-Shell or creating a shell program for the Bourne Shell are not only desirable in this case, but also necessary.

Ron Spizzirri, Technical Manager
Analysts International Corporation
650 Woodfield Dr.
Schaumburg, IL 60195

C Source-Code Formatting

I was overjoyed to see my preferred style of C source-code formatting in Houston, Brodrick, and Kent's article on CP/M-86 C compilers (page 82) in the August issue. I have always instinctively used that format, despite pressure to conform to convention, because it feels better to me.

I feel strongly that the matching-braces-in-the-same-column formatting style is preferable and hope that it will find wide acceptance, or at least tolerance, particularly by anyone who imposes formatting standards on programmers.

Peter Cann
Atari Incorporated
5 Cambridge Center
Cambridge, MA 02142

Unix Wasn't the First

"The History of Unix" (August, page 188) is interesting, but there is a major problem with the statement: "Until Unix, operating systems were written exclusively in assembly language."

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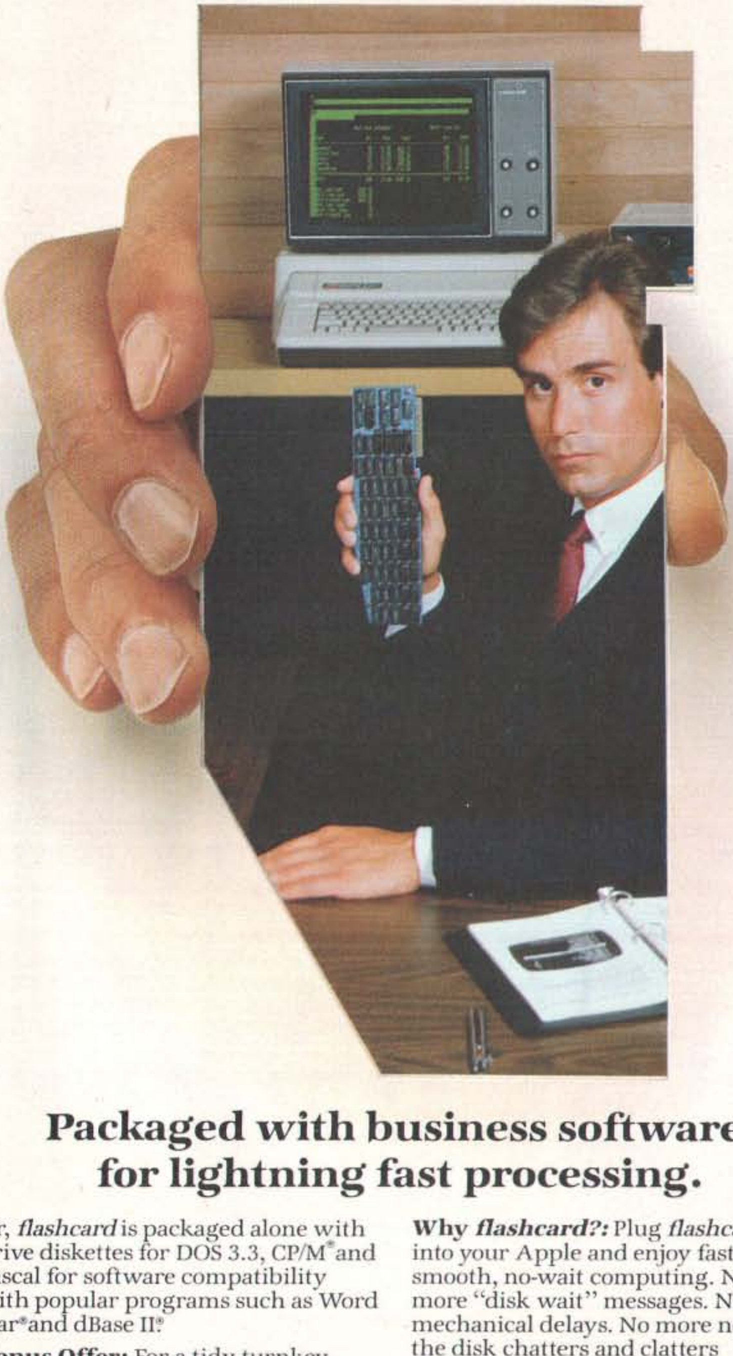

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Wrong!

The Burroughs B-5000 computer released in 1963 and later rereleased as the B-5500 used a multiprogramming/multiprocessing operating system written in a superset of ALGOL-60 called ESPOL. There has never been an assembly language and assembler for any of the Burroughs large computers including the B5700, B6500, B5900, B6700, B6800, B6900, B7700, B7800, B7900.

Harlan S. Barney, Jr.
Chief, EDP Technical Services
NYS Department of Transportation
Albany, NY 12232

What About MP/M-86?

In your Unix series, several authors pointed to 8-bit CP/M's deficiencies when compared to Unix. This is like accusing the IBM PC of serious deficiencies in numeric-processing ability when compared to the Cray X-MP.

None of the articles mentioned MP/M-86, Digital Research's 16-bit multiuser/multitasking operating system. Was MP/M-86 ignored because the authors' livelihoods are somehow tied to the success of Unix?

The switch to MP/M-86 is easy for the millions of CP/M users. The commands, with few exceptions or additions, are the same. Increasing numbers of CP/M packages are available for CP/M-86; most of these will run under MP/M-86 without modification. The result is a greater variety of familiar software.

Digital Research's operating systems would not win any prizes for user friendliness. However, their prompts and commands are generally more logical than those of Unix.

Despite all the recent Unix hype, I am nonplussed by the implied propensity for disk contention and its belated support of record locking.

BYTE should review MP/M-86.

Larry Koerv
Fortrex Corporation
POB 3610
Wichita, KS 67201

Speed Not the Issue

If Mr. Harp and Mr. Stone (Letters, October, page 20) of Oklahoma State University bought Radio Shack Model 16s to win BASIC-language benchmark contests

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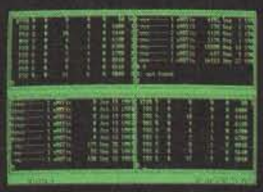

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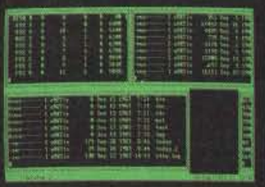

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then they indeed bought the wrong iron. The TRS-80 Model 12 and Model 16 are COBOL-oriented business data-processing machines. For a single workstation, the Model 12 is the more practical choice. For multiple users, the Model 16 is the only game in town. I agree that the two operating systems offered are not speed demons. But if the user sees apparently instantaneous response when he calls up a screen format or randomly updates a record, then that is fast enough for the purpose for which these machines were designed. Their forte is the ability to handle large files efficiently—commercial data-processing.

This is not intended to let Radio Shack off the hook for failure to provide a really good operating system. TRSDOS is user-friendly but slow. Xenix is the usual incomprehensible mess of gobbledygook that we have come to expect from Unix and its derivatives. We have the engineering profession to thank for designing it and the academic community to thank for praising it to the skies.

Despite these defects, if Mr. Harp and Mr. Stone want to unload a Model 16 at an attractive price, please ask them to get in touch. I know how to use the machine very effectively in a business-oriented environment, and my customers seldom do trigonometry in the middle of payroll.

John R. Culleton Jr.
President, Culleton Group Inc.
2401 Haight Ave.
Sykesville, MD 21784

Change of Address

I wish to point out an incorrect company address that ran in Dave Fiedler's "A Unix Tutorial" (October, page 134). The correct address for Unisoft Systems is 2405 Fourth St., Berkeley, CA 94710. The company's phone number is (415) 644-1230.

Trudi L. Jackson
Marketing Manager
Unisoft Systems
2405 Fourth St.
Berkeley, CA 94710

Praise for the HP-75C

As a salesman contentedly using an HP-75C for a year now, I read with interest the September articles on the new entries in the lap/portable computer market. It seems to me logical but unfair to give a computer only to an author for testing: the HP machine (deemed a calculator by Hewlett-Packard), with its multiple internal-file structure, quick conversion between text and BASIC, automatic pausing during entry of BASIC lines, convenient renumbering facility, password-protection features, and built-in mass storage (even if only in the form of a card-reader) is a uniquely useful on-the-go computational tool.

True, it hasn't a full-size typewriter keyboard and its keys are not full-stroke. But it is easy for anyone without an article deadline in mind to touch-type on the unit. Corrections are easy with its Insert/Replace mode toggle. And 26 ounces is certainly easier to carry than 4 pounds!

Visicalc on ROM is a marvel despite the 1-line display, and now there is an 80-column monitor adapter available as well, useful for viewing both spreadsheets and text files to be formatted by the Text Formatter ROM.

I think this machine has features to cover just about all the niggling complaints mentioned with the TRS-80

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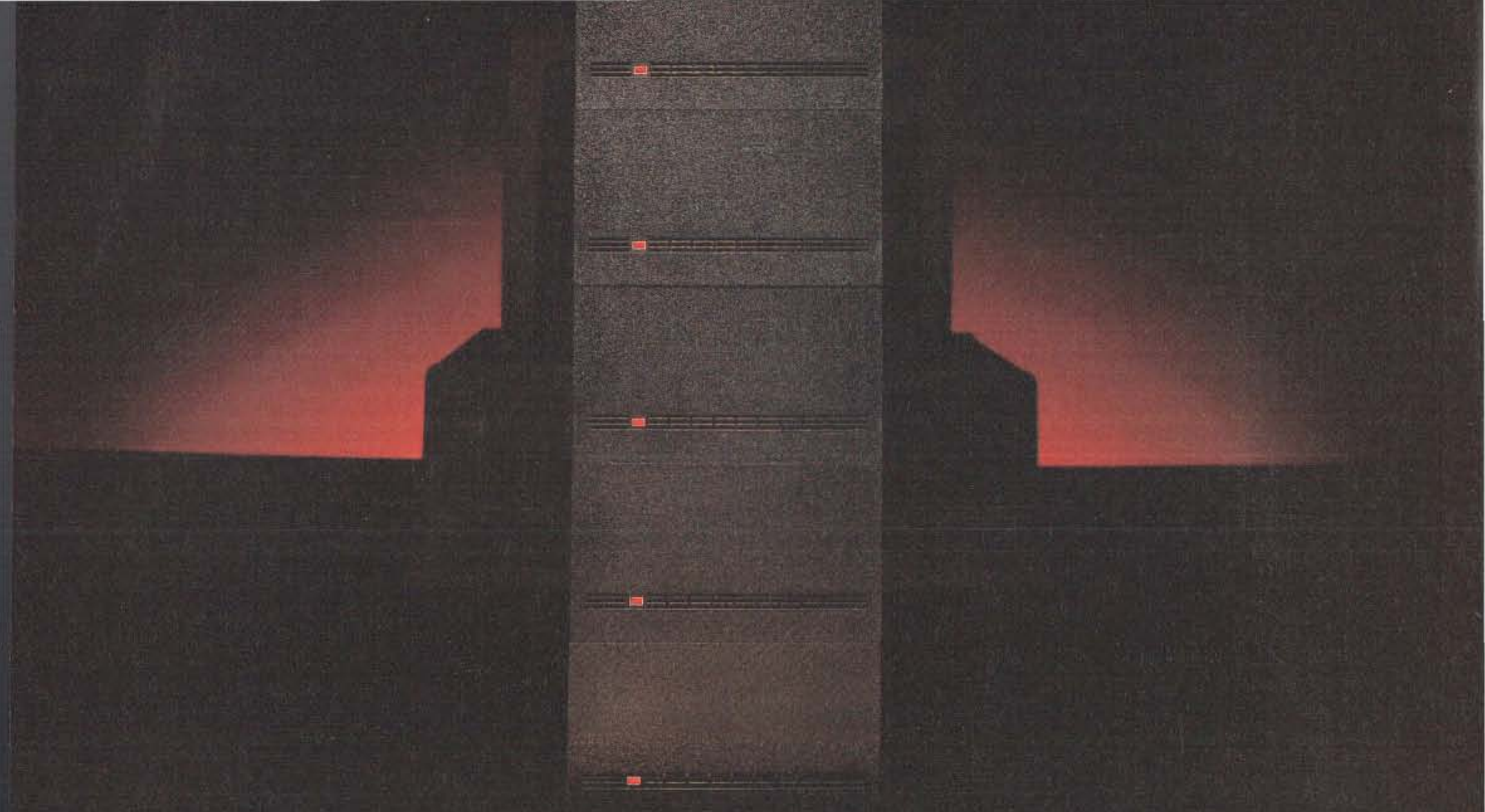

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Model 100 and other similar computers. And with the recently introduced RS-232C and IEEE-488 interfaces, the HP-75C becomes compatible with just about anything one may want to tie it to. The unit is powerful beyond its specification and deserves better press than it is getting.

W. Howard Cornelsen Jr.
2100 Tanglewilde #227
Houston, TX 77063

The Carnegie Foundation Report

The Carnegie Foundation for the Advancement of Teaching recently issued a report on secondary education in America. Its conclusions should deeply trouble everyone who is working to develop educational software and hardware.

The report states that "Computer companies are failing to prepare first-rate material linked to school curricula or objectives." It refers to a "moral obligation" and recommends that "every computer firm selling hardware to the schools also establish a special instructional materials fund." The fund would be used to help teachers develop curricula-related programs.

The report conveniently overlooks a few things. Many computer manufacturers have been giving equipment to schools. IBM has been doing this for over 30 years. Apple has given almost 10,000 systems to schools in California. Educational discounts have often approached 30 percent of the purchase price for equipment. Possibly the Carnegie Foundation feels this is not enough.

The foundation's report goes on to suggest that a national commission be named to review the quality of current educational software. It also calls for the creation of a number of university-based centers which will be used to test and demonstrate educational hardware and software. These are the sort of suggestions that give me the creeps. It doesn't take much imagination to see an "approved list" coming out of a review committee. The "approved list" can then be used to control purchases of software in all cases where federal funds are involved. The really fun projects in educational hardware and software—the ones based on the idea that there are innovative things that can be done with the curriculum—will be stillborn. That should worry us.

The author of the report, Ernest L. Boyer, is a former U.S. commissioner of education. The Carnegie Foundation's opinions carry weight in educational and public policy circles. It is tragic that the foundation's report makes computer manufacturers the whipping boys for problems that occur in introducing computers in a classroom setting. Manufacturers of hardware and software do not develop educational products from completely altruistic motives. But their record of providing goods and services to the educational community deserve much better than the kick in the teeth received from the Carnegie Foundation.

John Boddie
Specialized Computer Software
213 Aronimink Dr.
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Coping with Radiation

Having spent a number of years in front of a CRT monitor, I thought that I had experienced all of the evils that could befall a computerist. I felt that I must have a natural immunity to all of those vagaries described by workstation operators and CRT watchers. I had considered that these persons might be suffering from galloping hypochondria. It also had crossed my mind that they were trying to build a case for a massive class-action lawsuit against the inventors of the CRT (look out, heirs of J. J. Thomson, Dumont, et al). Maybe they were looking for lifelong employment-disability benefits.

Last week, during a massive data-research effort, I had occasion to spend two days in front of a microfiche reader. The results during the first day were interesting and possibly worth consideration by all who use CRT terminals or workstations:

After finishing seven hours, I had burning eyes, a tenseness in the shoulder muscles, a mild headache, an uneasiness in the lumbar region of the back, a dryness in the throat, a feeling of uneasiness as I left the parking lot, severe stress, fatigue, and irritability during the freeway commute to home. After dinner at home, I experienced definite eyestrain while reading the evening paper, a dis-

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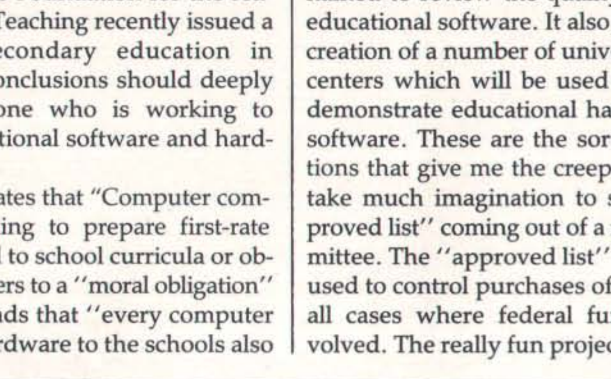

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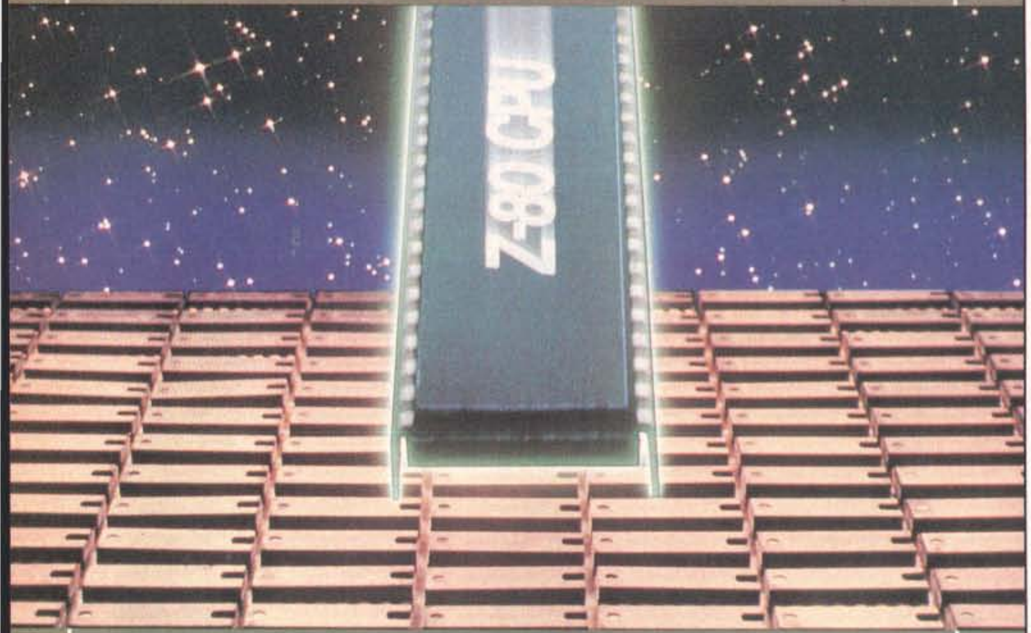

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tinct backache, indigestion, and a headache which got worse when I went to bed.

The next day I took a pitcher of water, drinking glass, and pocket calculator with timer-alarm into the microfilm and fiche room and took a break every 15 minutes for a swallow of water. I made a point of correcting my posture and taking several deep breaths everytime I changed a fiche. A little isometric game also helped to reposition the muscles on my frame. I used a pair of dime-store reading glasses which moved my point of focus out to 24 inches instead of the 16 inches I use for reading and desk work. These placed me at a better position in relation to the screen. Using these tricks, I was free of the symptoms of the previous day.

Is there anyone who knows how much low-level radiation is emitted by a 150-watt, incandescent projection lamp?

Paul M. Hine
Engineer, Q.E.D. Systems Inc.
1525 Standlake St.
San Diego, CA 92154

Formatting Rainbow 100 Disks

I recently bought a DEC Rainbow 100 Personal Computer, but I was disappointed by the lack of a program to format disks. After a little search, I succeeded in writing one myself.

Last month I read some complaints about this problem, so I am offering my Format program to other Rainbow 100 users for the nominal charge of $50 (media, copying, and postage included).

Paolo Prandini
Viale Europa, 72/G
25100 Brescia
Italy

In Praise of the TRS-80 Model 100

I enjoyed "The Radio Shack TRS-80 Model 100" by Mahlon Kelly (September, page 139). I have traveled with the Model 100 for the last six months, through seven countries. It is all that it is reputed to be. I have hooked this box to just about everything available; it has yet to let me down. I have even used it as a limited datascope. With a few more pins on the RS-232C bus connected, we could have the first truly portable model.

William N. Carter
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Letter Shows Mathematical Naiveté

G. M. Harding's letter (September, page 10) labeled "Bug-Free But Meaningless" is itself meaningless. Harding attacks the notion of the utility of the methods of calculus to analyze economic data "in the same way as a continuous function in mathematics." Harding seems to believe that because, on a very small scale, the events from which economic indices are derived are not discrete, the methods of differential and integral calculus are therefore invalid and cannot be applied.

This is mathematically naive, as anyone who has studied the science of statistics will be aware. To give a simple example, suppose one takes a coin and tosses it a given number of times. The probability that the coin will come up heads can be exactly determined by calculating the coefficients of the binomial expansion of the same order as the number of tosses. When the number of tosses in a run becomes large, however, this calculation can become tedious, and in this case the Gaussian approximation (the familiar bell-shaped curve) is generally used. It is easily shown that the larger the number of tosses in a run, the more closely the probability distribution is modeled by the continuous Gaussian function.

On a more complex level, there is the treatment of the problem of a quantum-mechanical gas in a periodic lattice (a problem of some interest to computer science, for it is the understanding of this that led to the development of semiconductor electronics). The physical system is constrained to have discrete energies and momenta, which are thought of as points in a multiple-dimensioned "phase space." The calculation of certain important quantities, such as the number of available states the system may occupy, is simplified by assuming for purposes of calculation that the available states form a continuum whose volume can be calculated geometrically. Again, a large number of available states will entail that the difference between the true number and the number calculated by this means is insignificantly small.

Statistical mechanics may seem a far cry from econometrics, but the mathematics that goes into them both is the same mathematics. Harding may choose to believe that the math is invalid, but the silicon chips in computers will continue to function as predicted by quantum statistics, and this is not a reasonable critique of modern economics.

Another remark Harding makes is that "even if" this sort of reasoning is acceptable, identifying the effects of certain events in time series of economic data is not reasonable. Although not entirely wrong, Harding is far from correct. It is possible to see structures not inherent in the data, structures that appear, perhaps, as an artifact of the analysis technique applied. However, there are methods of inferring the significance of statistical results. A savvy user of these methods is capable of discerning whether the results of a study are meaningful or not. Judging from the level of statistical literacy in the letter, Harding is not capable of making such discernments.

Alan L. Bostick
6400 Latona Ave. NE
Seattle, WA 98115 ■

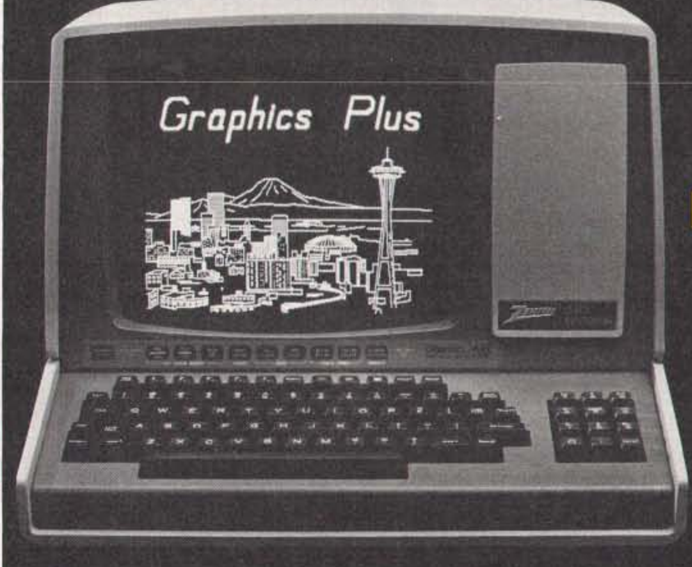

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Photo 1: *Your computers and other electronic equipment are vulnerable to disturbances transmitted through the power line. Most of the components necessary for transient and noise suppression can be purchased from Radio Shack. Shown here are a commercial EMI/RFI line filter made by Corcom and two General Electric metal-oxide varistors.*

Keep Power-Line Pollution Out of Your Computer

by Steve Ciarcia

A visitor once called the Circuit Cellar my mountaintop wilderness retreat. Since he lived in the center of Manhattan, the few oak and birch trees around my house seemed to him like a forest, and because he could view scenery further away than a block or two he must have felt like he was on Mount Whitney. Well, my area is one of the higher points in Connecticut, but that isn't very high. It's barely a prairie-dog mound to someone from Montana.

Life in a rural location has its special pleasures. I get to plow the snow from my own driveway, trim back the ever-encroaching foliage and rake the leaves, pile four cords of wood for the stove each winter (see reference 1), fight off the local animal population, and spend large sums of money repairing damage done to my electronic equipment by electrical disturbances.

This last item is the only one that really annoys me. Every year I can count on experiencing some equipment failure attributable to an external electrical impulse, usually coming in through the power line. For three years, just like clockwork, the first thunderstorm in June wiped out a DECwriter II terminal connected to one of my computers. After the first two times of spending a few hours replacing blown chips, I got smart and installed sockets. (Now I even know in advance which chips will be blown.) Last summer I kept the printer unconnected when I wasn't using it.

But the elements were not to be denied. During an August thunderstorm, lightning struck my house. I can't say for sure where the bolt actually hit (there were no burn marks or other visible clues), but I suspect the point of entry was the power line. I remember seeing an indistinct flash of light, hearing a tremendous crash, and then standing in darkness. My assistant Jeanette saw a bright blue glow behind one of the computers.

Such a tremendous power surge is not kind to semiconductor-based equipment. The casualties included one computer, one video camera, two video monitors, a microwave receiver, and probably several other assorted items I haven't found yet. The damage did not include the DECwriter (safely unplugged since May), but it was over $3000.

In December, thunderstorms are not an immediate threat, but as I write this in early September the memory is still fresh and I still have a month of potentially violent weather to contend with. I am forced to consider some defensive measures. Perhaps by relating my experiences I can save you from a similar fate.

Of course, lightning isn't the sole cause of electrical disturbances; you don't have to wait for a thunderstorm to be a victim. Many kinds of trouble can be ducted into your computer through the power line.

In the January 1981 Circuit Cellar article (reference 2), I wrote about electromagnetic interference (EMI) and radio-frequency interference (RFI). This month I'd like to pick up the saga by describing other forms of electrical pollution that occur on power lines. Afterward, I'll describe a few simple, inexpensive means of dealing with them.

The Power Line: A Hostile Environment

The lines leaving your local utility company's generating plant carry electrical power that in most respects is pure, smooth, and constant. However, as the power is routed through the distribution network, it comes under the increasing aberrant influence of external forces and the connection or shedding of electrical loads.

Your susceptibility to these aberrations depends on your location in the distribution system. If you are close to the power plant, you should have relatively few, with the low source-impedance of the generator and short distance of the transmission line limiting the influence of external forces. But rural customers at the end of the line usually experience the full effect. While the utilities try to distribute power evenly, the presence of a large-scale user of electrical power along the line between the generator and you can greatly affect the quality and quantity of the power you get.

If you own a personal computer, you should be concerned about the quality of the power you feed it. Power-line irregularities cause problems for computers and other digital equipment because certain kinds of extraneous electrical pulses can be interpreted as data or instructions, causing errors in operation. You face hazards every time you plug in a piece of electronic equipment, but there are certain precautionary measures that can protect your computer.

The degree of sensitivity depends somewhat on the type of equipment and the type of disturbances. As the operating speed of digital equipment increases, its tolerance to power-line pollution lessens. High-speed processors and memory components are susceptible to fast transients. (Dynamic memories, which must be periodically refreshed, are particularly susceptible.) Disk drives and displays, on the other hand, are more affected by lasting surges and sags in operating voltage.

Common Sources of Woe

Electrical power-line disturbances can come from either natural or man-made sources. Of the many ways the power line can be disturbed, the several varieties of voltage fluctuation most often cause problems with computer equipment. These fluctuations can be categorized by source and severity, as follows:

Blackouts. A blackout is a total power outage—the voltage goes to zero. Obviously if no alternate source of power is available as a backup, computer equipment will be severely affected, and data will be lost. Blackouts generally affect only a small number of utility customers (fewer than 5 percent) during a year and generally last less than 10 seconds.

Brownouts. A brownout is typically a corrective action taken by the utility when power demand exceeds generating capacity. The utility reduces the output voltage from a nominal 120 V (volts) by 5 to 15 percent. When the voltage is thus reduced, the resistive load presented to the generators by the distribution network consumes less power.

Generally speaking, most consumer and industrial equipment designed for use in North America functions properly when supplied with current within the range from 105 to 130 V. But when operating at either extreme, the equipment is more vulnerable to disruption from some other power-line anomaly. Fortunately, power companies rarely reduce the voltage by more than 7 percent.

Voltage transients. The phenomena of voltage transients include surges of voltage above the specified normal, voltage sags below, and instantaneous voltage spikes that leap far above the nominal levels.

Surges and sags are long-duration events occurring at some point in the distribution network when electrical equipment is routinely turned on or off nearby. The magnitude of the surge or sag depends upon the size of the load being removed from or placed on the network.

Sags are often produced by the turning on of electric motors, which have high starting currents. (You've probably noticed lights dimming

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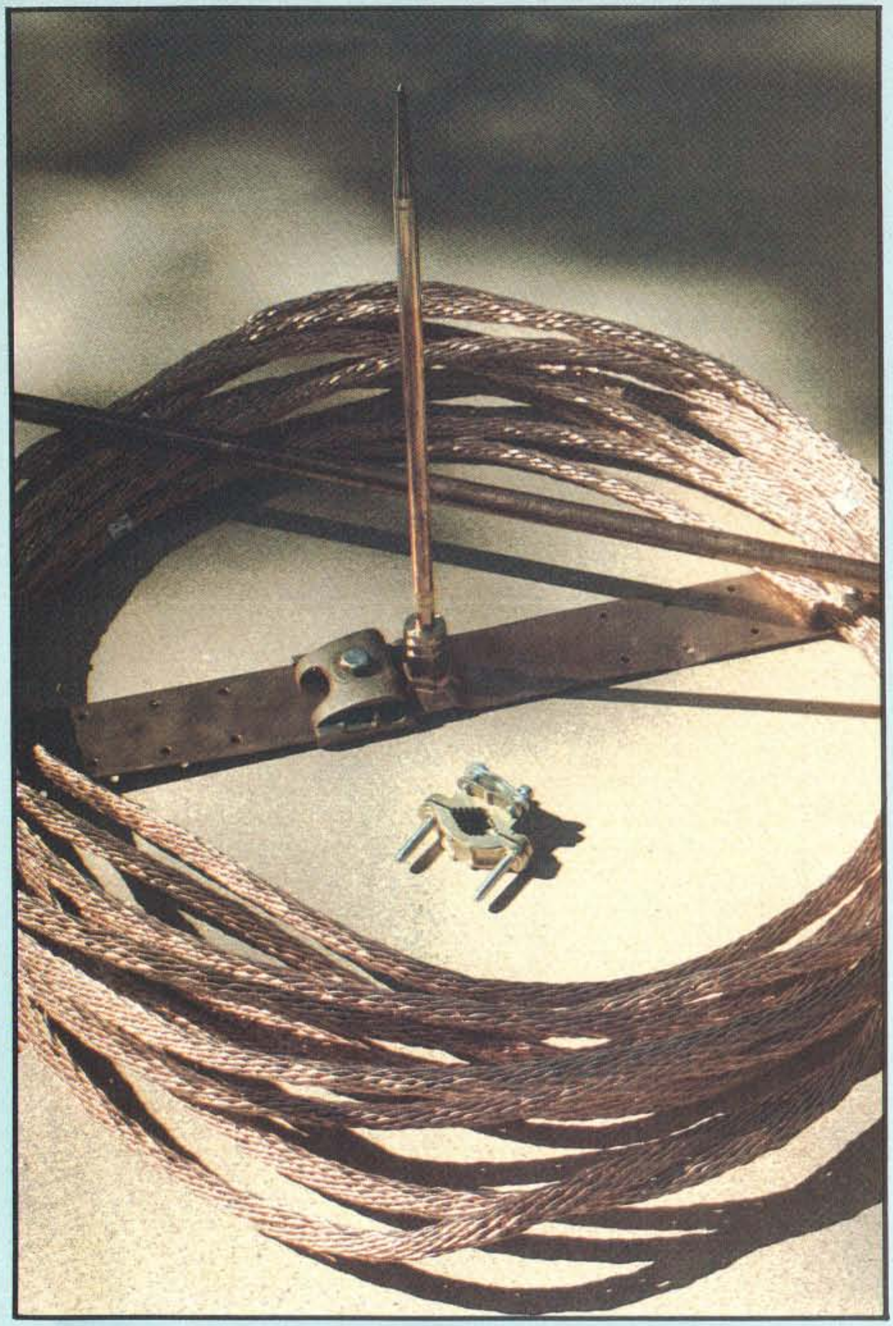

The important element in lightning protection is the lightning rod, a pointed shaft of copper to which a half-inch copper cable is fastened. The cable in run down the side of the building, where it is clamped to an 8½-foot copper-plated steel rod driven into the earth. The rod system pictured here costs $150.

How Lightning Strikes

A lightning flash is characterized by one or more strokes with typical peak currents of 20 kA (kiloamperes) or higher. In the immediate vicinity of the stroke's impact on the earth, hazardous voltage gradients exist. It is difficult to establish a definite grounding-conductance value necessary to protect equipment and personnel. The current in a lightning strike is so high that even 1 ohm of resistance can theoretically produce hazardous potentials.

When lightning strikes a building unprotected by a lightning rod, the stroke seeks out the lowest-impedance path to earth (most likely through the electric wiring or water pipes).

How It Starts

As the electric charge builds up in a cloud, the electric field in the vicinity of the charge center increases to the point where the air starts to ionize. A column of ionized air, called a pilot streamer, *begins to extend toward the earth at a velocity of about 100 miles per hour. After the pilot streamer has moved perhaps 100 feet to 150 feet, a more intense discharge called the* stepped leader *occurs. This discharge inserts additional negative charge into the region around the pilot streamer and allows the pilot streamer to advance for another 100 to 150 feet, after which the cycle repeats. As its name indicates, the stepped leader progresses toward the earth in a series of steps, with a time interval between steps on the order of 50 microseconds.*

In a cloud-to-ground flash, the pilot steamer does not move in a direct line toward the earth but instead follows the path through the atmosphere where the air ionizes most readily. Although the general direction is toward the earth, the specific angle of departure taken by each succeeding pilot streamer from the tip of the previous streamer is unpredictable. Therefore, each 100- to 150-foot segment of the stroke will likely approach the earth at a different angle. This changing angle of approach gives the overall flash its characteristic zigzag appearance.

As a highly ionized column, the stepped leader is at essentially the same potential as the charged area from which it originates. Thus, as the stepped leader approaches the earth, the voltage gradient between the earth and the tip of the leader increases. *The increasing voltage further encourages the air dielectric between the two regions to break down.*

Attracting Lightning

Objects extending above their surroundings are likely to be struck by lightning. Thin metallic structures, such as flag poles, lighting towers, antennas, and overhead wires, offer a very small cross-sectional area relative to the surrounding terrain, but ample evidence exists to show that such objects apparently attract lightning.

The ability of tall structures or objects to attract lightning serves to protect shorter objects and structures nearby. In effect, a tall object establishes a protected zone around it; within this zone, other structures and objects are protected against direct lightning strikes. As the height differen-

tial between the shorter surrounding objects and the tall one decreases, the protection provided to the shorter objects decreases. Likewise, as the horizontal distance between the tall and short structures increases, the protection afforded by the tall structure decreases.

Lightning Rods

A protective device that makes use of this phenomenon is the lightning rod, shown in photo. Generally just a sharp copper spike, the lightning rod is attached to the highest point on the structure to be protected. When lightning strikes, the current is shunted directly through a heavy copper wire from the rod to a grounding electrode buried in the earth.

Although the duration of a strike is typically less than 2 microseconds, the voltage generated is high enough to cause flashover strikes to conducting objects located as much as 14 inches away from the conducting path. For this reason, metallic objects in close proximity to down conductors should be electrically bonded to the conductors.

But circuits not in direct contact with the lightning discharge path can experience damage, even in the absence of overt coupling by flashover. Because the high current associated with a discharge builds up so fast, large inductively produced voltages are formed on nearby conductors. Experimental and analytical evidence shows that the surges thus induced can easily exceed the tolerance level of many components, particularly solid-state devices. Inductive surges can be induced by lightning current flowing in a down conductor or structural member, by a stroke to earth in the vicinity of buried cables, or by cloud-to-cloud discharges occurring parallel to long cable runs, either above ground or buried.

The Moral

The objective of all lightning-protection systems is to direct the high currents away from susceptible elements or limit the voltage gradients developed by the high current to safe levels. In a given area, certain structures or objects are more likely to be struck by lightning than others; however, no object, whether man-made or natural, should be assumed to be immune from lightning. The voltages that could be induced by such discharges present a definite threat to signal and control equipment, particularly equipment employing semiconductor components.

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(603) 859-7110

Corcom Inc.
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Libertyville, IL 60048
(312) 680-7400

Curtis Industries Inc.
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Milwaukee, WI 53223
(414) 354-1500

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San Fernando, CA 91342
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Siemens Corporation
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(602) 941-6366

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North Adams, MA 01247
(413) 664-4411

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Santa Clara, CA 95050-1997
(408) 988-0700

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Cornell-Dubilier Electronics
Box B-967
New Bedford, MA 02741
(617) 996-8561

when an air conditioner comes on.) Surges are generally the result of network switching by the utility or of a sudden reduction in demand for power in the network; during the period necessary for the utility's electromechanical compensation system to function, an overvoltage transient condition can exist.

The most damaging power-line disturbance is the high-speed, high-energy *voltage spike*. People speaking loosely about "power-line transients" are probably talking about this type of event. Lasting usually less than 100 microseconds, spikes can be up to 6000 volts. Such high-energy transients are produced by the switching off of inductive loads by the opening of switch contacts, short circuits, or blown fuses; severe network load changes; or lightning. Inductive-load switching accounts for the majority of spikes.

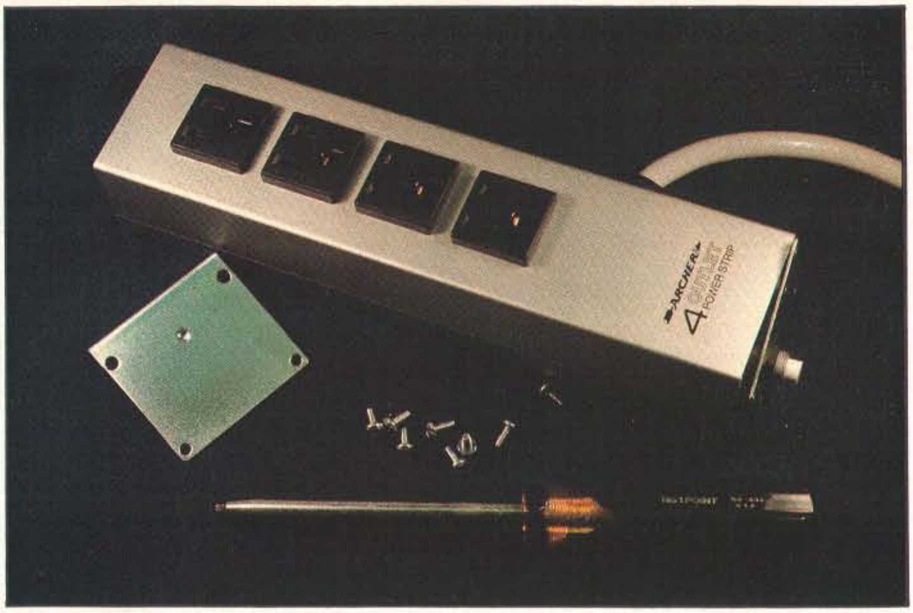

Photo 2: *You can save approximately $40 on the price of a transient-protected power strip by adding the protection yourself, as demonstrated on the Radio Shack Archer 61-2620 unit. First, unscrew the end plates.*

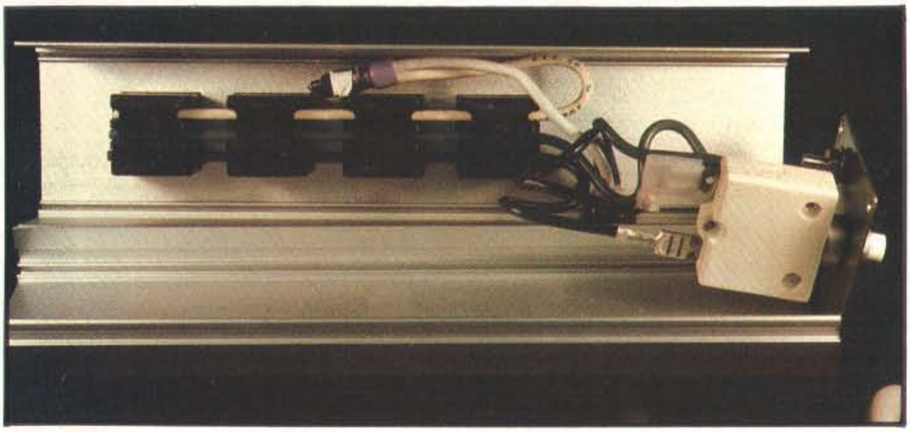

Photo 3: *Open the strip case, exposing the four receptacles and the white circuit-breaker block. The three wires conducting power run the length of the strip: black is the hot side, white is the neutral return, and the green wire is earth ground.*

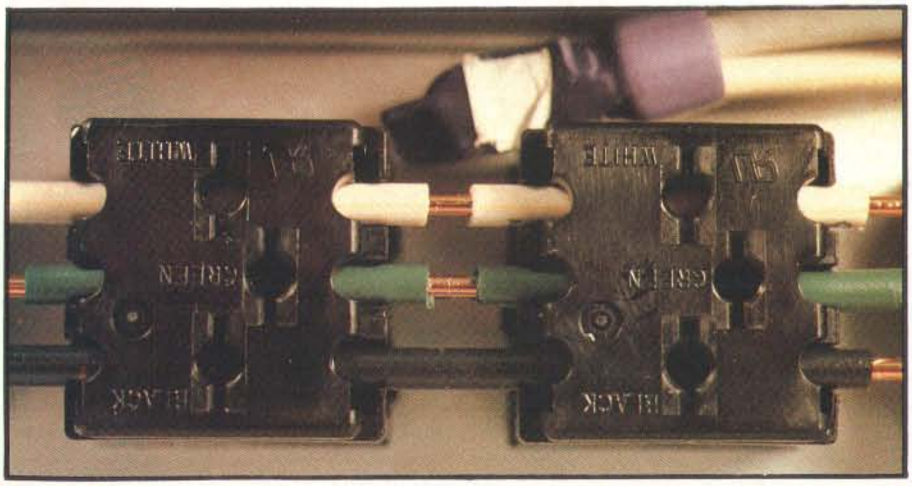

Photo 4: *Using an X-acto knife or similar tool, strip insulation from the wires between the receptacles (which I number 1 through 4, from left to right) according to the following system: between 1 and 2, strip the green and black; between 2 and 3, strip the green and white; between 3 and 4, strip the black and white.*

When the coil of an inductive load such as a transformer or motor is suddenly deenergized, the collapsing magnetic field must dissipate its energy, and it does this by placing a large voltage back into the circuit that energized it. Let's examine the process in detail.

As the circuit through the inductor is broken, current in the inductor continues to flow, charging the distributed capacitance in the windings. At some point, the charge voltage becomes sufficient to leap across the switch gap as a spark. This sudden shorting action discharges the winding's capacitive charge back into the circuit until the spark ceases. This process repeats in a cycle until there is too little energy left in the coil to create an arc across the contacts. The waveform of inductance-generated transients is oscillatory. For example, a contact opening while conducting 100 mA (milliamperes) in a 1-H (henry) inductance will produce a 3000-V spike, assuming about a 0.001-μF (microfarad) stray winding capacitance.

Whenever you plug in a vacuum cleaner, hair drier, or other appliance (even your computer), you could be creating some potentially serious transient disruptions for other equipment on the same power line. The equipment need not even be on the same wiring circuit. The capacitance of household wiring is often sufficient to couple a transient from one wire to another (differential mode) or from the wire to the ground (common mode).

Lightning is the most violent and most destructive source of transient energy. A direct lightning hit is catastrophic, but direct hits seldom occur. A more frequent danger is that a lightning strike on a power line miles away may result in a thousand-volt spike rushing throughout your home. Such hits happen frequently enough to cause much grief. (Because lightning is such a significant source of transients, I've explained it in detail in the text box "How Lightning Strikes." A secondary, and more widespread, effect of a lightning hit on a power line is a voltage sag over a large part of the network as the power company's safety circuits compensate for the spike.)

Electrical noise. Miscellaneous electrical noise is the final source of power-line disturbances. It is best understood as high-voltage high-frequency interference. Noise in the range from 10 kHz (kilohertz) to 50 MHz (megahertz) is the most common cause of computer failures. Because of its frequency, noise can be either broadcast through free space from its source or conducted directly through the power lines. Digital electronic equipment is a prime source of high-frequency noise.

Power-Line Protection

I'm not trying to make you afraid to plug your computer into the wall outlet. There are remedies for virtually all the problems I've mentioned, although some are more practical for some computer users than others.

If surges or sags are a constant problem for you, you can try having the power company change the tap on your local step-down transformer or installing a constant-voltage transformer on your premises. These measures, although expensive, are effective. If you are plagued by blackouts or have equipment that should never be shut down, I suggest that you consider obtaining an *uninterruptible power supply*, abbreviated UPS. Using a UPS gives you confidence in the quality of your power and effectively isolates your computer from damaging perturbations. However, a UPS is also quite costly.

In the case of electrical noise and EMI, there are filters and construction techniques that can be employed to reduce interference, but a better answer is to find the pollution at the source and eliminate it. My article in the January 1981 BYTE outlined most methods of filtration and preventive design. While I'll try not to belabor the point, a power-line filter is an important noise- and transient-suppression device.

The best answer to transients is to suppress their voltages to a harmless level, either with filters or a special category of components called *transient suppressors*.

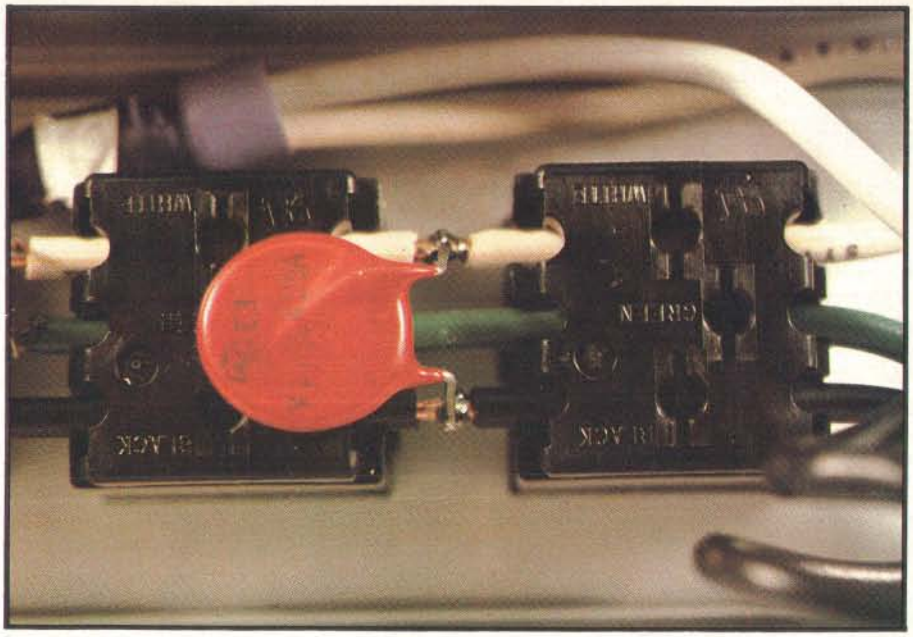

Photo 5: *You can now solder a varistor between each of the stripped wire pairs, mounting it flat against the back face of the receptacle so that the case will fit together again.*

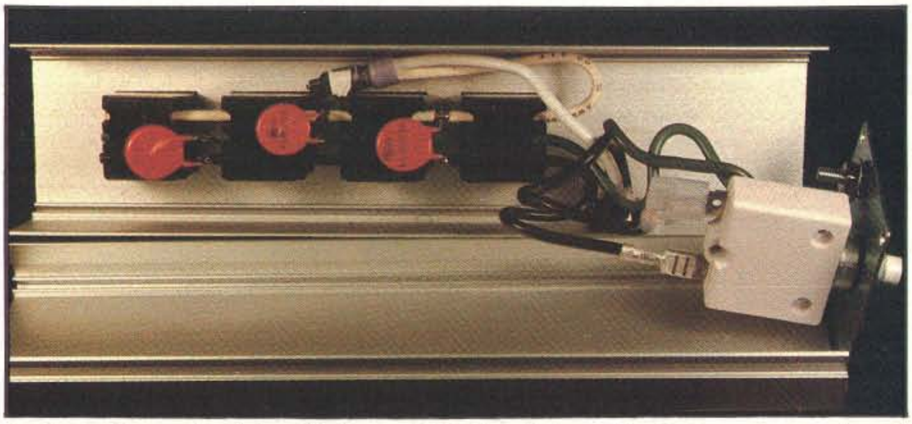

Photo 6: *The outlet strip with three MOVs installed provides both common-mode and differential-mode transient suppression. After you have finished soldering, carefully reassemble the power strip's enclosure and screw it back together.*

Power-Line Filters

A power-line interference filter is an electronic circuit used to control RFI and EMI conducted into and out of equipment. The filter is intended to provide unwanted interference signals with a high series impedance (into the vulnerable equipment) and low shunt impedance (to ground). It generally consists of a set of passive components that act as a mismatching network for high-frequency signals—a low-pass filter. The network attenuates RF energy above 10 kHz, while passing the 60-Hz power.

The simplest possible filter is a single capacitor wired in parallel or a single coil wired in series with the power line. More typically, several capacitors and/or coils are used together, connected into different configurations variously called L, π, and T filters.

Though containing only a few components, such passive bilateral networks have complex transfer characteristics that are extremely dependent upon the impedances of the source and load. Because you can't predict these impedances for all applications, it is not possible to unequivocally state that a specific filter configuration will work the same way in two different environments. But to allow

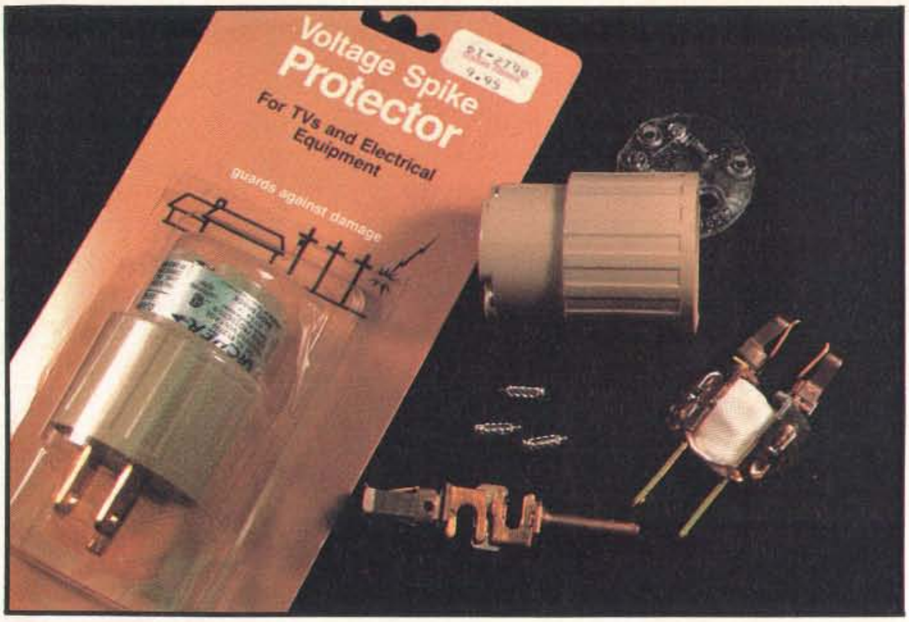

Photo 7: *For quicker and easier, though incomplete, protection, you can plug your computer into a simple voltage-spike protector such as the Radio Shack 61-2790. As you can see from the disassembled unit, the metal-oxide varistor (wrapped in fiberglass tape) is connected between only the hot and neutral lines (black and white). It has no varistor connection to the ground lead and therefore does not protect against common-mode transients.*

electrical specifications to be minimally compared, however, resistive source and load impedances of 50 ohms each are generally used.

Two similar power-line filters, even built with the same circuit topology and component values, may not perform identically; the mounting and wiring of the filter can be critical influences on its performance. A power-line filter is best installed at the point in your equipment where the power line comes inside the case rather than at the far end of a long cord. The filter's purpose is to attenuate high-frequency signals: this purpose is defeated if these parasitic signals can gain access to the equipment by capacitively coupling to the power cord at a point behind the filter.

It's not always possible to disassemble your computer to add a line filter, but the best location for a power-line filter is bolted to the chassis of the electronic equipment it protects, or at least in the immediate vicinity, such as at the power receptacle.

While you could construct a line filter using the formulas and designs from a magazine article, I heartily recommend that you buy a packaged unit instead. The selection is easier and much more controlled using commercial line filters (see the text box on page 39). So much depends upon component selection and layout that the only way to make sure power-line interference has been eliminated is to actually test the filter in your equipment. A circuit designed according to theory using a 50-ohm assumed impedance probably won't work as well as one empirically derived using the actual equipment and power line.

Transient Suppressors

Protection from the various kinds of line transients is obtained by suppressing or diverting them. The three types of circuits most often used for this are filters, crowbars, and voltage-clampers.

As I previously alluded, *filters* comprising inductances and capacitances are widely used for interference protection, including transients. Since most transient signals are high frequency, the suppression by a filter is often effective, provided it can withstand the associated high voltages.

Crowbar circuits use a switching action, such as turning on a thyristor or arcing across a spark gap, to divert transients. But crowbars that incorporate SCRs (silicon-controlled rectifiers) and triacs are much too slow to effectively suppress 100-μs (microsecond) transients. Most often they are incorporated in low-voltage DC power-supply output circuits where overvoltage conditions occur at more manageable speeds (milliseconds). Spark-gap devices, which include carbon blocks and gas tubes, are fast

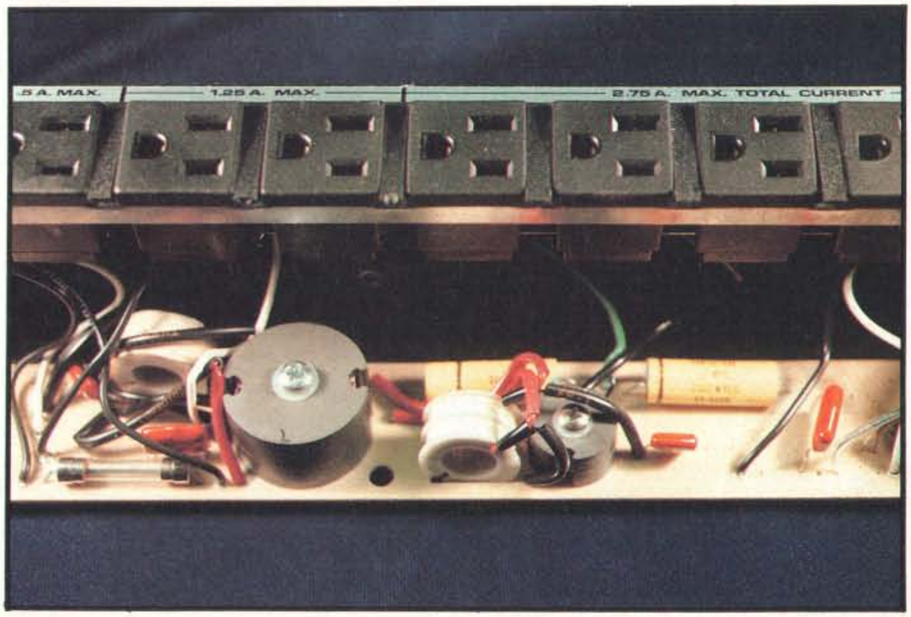

Photo 8: *Some line filters are made to work in specific circumstances. This Radio Shack power-line-filter strip (stock number 26-1451) was devised to cure interference problems with the TRS-80 Model I computer; it contains two separate LC (inductance/capacitance) interference filters but no varistors. If you have this strip, I suggest you install some MOVs.*

(1a)

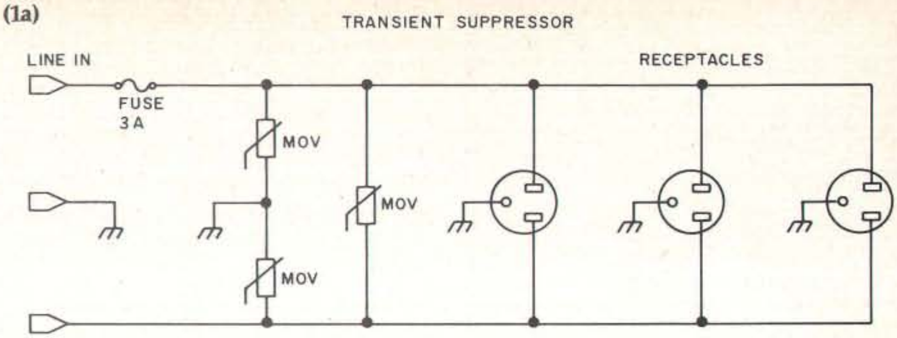

Figure 1a: *The Radio Shack four-outlet power strip can be easily modified to protect equipment from high-energy power-line transients. Three General Electric V130LA10A metal-oxide varistors (MOVs—Radio Shack number 276-570) are connected between the hot, neutral, and ground wires of the power line.*

(1b)

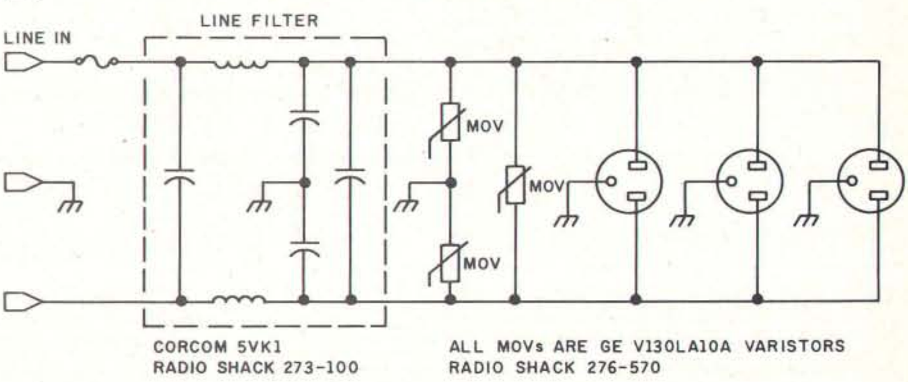

Figure 1b: *For added protection against low-energy electromagnetic and radio-frequency interference, the Corcom 5VK1 line filter (Radio Shack 273-100) can be installed in the circuit.*

and effective, but they trigger at relatively high voltages, making them unsuitable as the sole protection for semiconductor circuitry.

Voltage-clamping devices, on the other hand, have impedances that vary as a function of either the voltage across or the current through them. The circuit being protected is unaffected by the presence of the clamping device unless the incoming supply voltage exceeds the clamping level, as would be the case when a transient hits. The various kinds of high-speed voltage-clamping devices include selenium cells, zener diodes, silicon-carbide varistors, and metal-oxide varistors. Of these, the *metal-oxide varistors,* or MOVs, hold a significant price/performance advantage and are highly applicable in personal computing applications.

MOVs to the Rescue

Metal-oxide varistors are voltage-dependent nonlinear devices that behave somewhat like a back-biased zener diode. When a voltage lower than its conduction threshold is applied across it, the MOV appears as a nonconducting open circuit. But if the applied voltage becomes greater than this set point (when a transient hits), the MOV begins to conduct, clamping the input voltage to a safe level. In effect, the MOV absorbs the transient and dissipates the energy as heat.

An MOV is made of zinc oxide combined with small amounts of bismuth, cobalt, and manganese. The individual zinc-oxide grains form many *p/n* (positive-doped/negative-doped) junctions that combine in a multitude of series and parallel arrangements. This diversity of microstructure causes its nonlinear semiconducting characteristics. An MOV is inherently more rugged than a single-junction semiconductor device (a zener diode, for example) because energy is uniformly absorbed throughout the bulk of the component.

The physical dimensions of the MOV determine its characteristics, its conduction-threshold voltage varying as a function of thickness, and its energy-dissipating capacity varying according to volume. MOVs are available in operating voltages from 6 to 2800 V, with peak current capacities of up to 50,000 A (amperes). MOVs respond to transients in only a few nanoseconds and are relatively inexpensive. The chief producer of MOVs is the General Electric Company.

Protect Your Computer

Large companies sometimes solve power-line problems by producing their own power. In the home or small office, it's more practical to protect your computer and peripherals through comprehensive application of filtering and transient suppression.

Most of the commercially available filtered power strips contain MOVs as their primary suppression device. Even those costing $50 or $75 rarely contain more than $5 worth of transient protection. By purchasing the suppression components separately and installing them yourself, you can save a lot of money.

The majority of the projects I've presented in Circuit Cellar articles can be built for $50 to $2000, but the project this month wins hands down for economy. For the most part, line filters and MOVs are available off the shelf, and adequate transient suppression for your computer might cost as little as $1.59!

You can take two approaches in installing suppression. If you are interested in protecting only a few items of equipment, MOVs can be wired across the AC line where it enters the enclosures. You can find the General Electric V130LA10A MOV component at Radio Shack for $1.59 (stock number 276-570). This device is ideally suited to 120-VAC applications. It has an energy rating of 38 joules (watt-seconds) and will clamp to 340 V at 50 A within 35 ns (nanoseconds). Its peak-current rating is 4500 A. (For heavier duties, you'll need to use V130LA20A or V130PA20A MOVs.)

(As a rule, if you are going to be

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working inside the equipment you should also install line filters. You can buy Corcom type-5VK1 5-A RFI power-line filters at Radio Shack for $11.95 (stock number 273-100). These units, like the one shown in photo 1, are adequate for most consumer applications and fit in very nicely with existing equipment.)

The easier alternative is to modify a regular power strip to include transient suppression. Radio Shack's 4-outlet strip (number 61-2620, costing $15.95) is perfect for this application. Merely open it up and install three MOVs, as demonstrated in the series of photos 2 through 6, connected as shown in figure 1. One MOV is installed directly between the black (hot) and white (neutral) leads, the second MOV is connected from the black lead to the green (ground) wire, and the third from the white to the green. While you might squeak through by installing one MOV across the line, complete common-mode and differential-mode suppression requires three MOVs. (Photo 7 shows a commercial adaptation of the simplified scheme.) The price for all the parts of the protected power strip is $20.72. If you were to buy a larger power strip or build your own distribution box, you could also add a power-line filter. And if you have a filter strip already on your computer, you might want to check its degree of transient protection (see photo 8).

An Ounce of Prevention . . .

This project may not seem very exciting. I didn't find the idea very exciting, either, until the flash and subsequent smoke coming out of my favorite article-writing computer provided all the excitement I'll need for months. Most of the $3000 worth of damage I had was for equipment plugged into a single circuit, some of it on the same power strip. I had always known the protective value of MOVs, but I thought it wouldn't happen to me. A few dollars' worth of parts could have saved a lot of aggravation.

Voltage spikes and power-line disturbances aren't always the result of storm activity. Transient-caused equipment failures can happen any-time. The events I've described just served as a catalyst for presenting the subject. And even if lightning never hits you, you should know that many of the new computers I have been evaluating this year have shown an increased sensitivity to external interferance, including power-line glitches. You wouldn't want to find your new computer rebooting suddenly at a critical point or discover the memory to be scrambled after you plug in a printer on the same outlet. Transient suppression constitutes an ounce of prevention. You can spend thousands for the cure.

Next Month:

A new integrated circuit from National Semiconductor permits an intelligent video-display terminal to be built from only 21 chips.■

To receive a complete list of Ciarcia's Circuit Cellar project kits available from the Micromint, circle 100 on the reader service inquiry card at the back of the magazine.

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, product development, and marketing. In addition to writing for BYTE, he has published several books. He can be contacted at POB 582, Glastonbury, CT 06033.

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1. Ciarcia, Steve. "A Computer-Controlled Wood Stove." February 1980 BYTE, page 32.
2. Ciarcia, Steve. "Electromagnetic Interference." January 1981 BYTE, page 48.
3. Roberts, Steven K. *Industrial Design with Microcomputers.* Englewood Cliffs, NJ: Prentice-Hall, 1982.

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains articles from July 1980 through December 1981.* Ciarcia's Circuit Cellar, Volume IV, *soon to appear, will contain articles from January 1982 through June 1983.*

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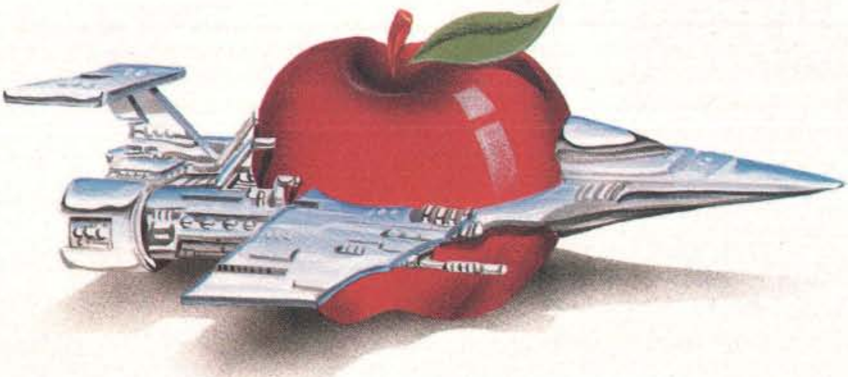

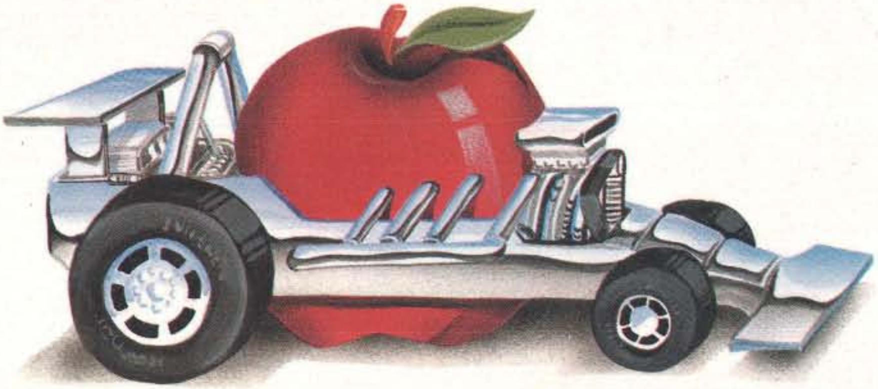

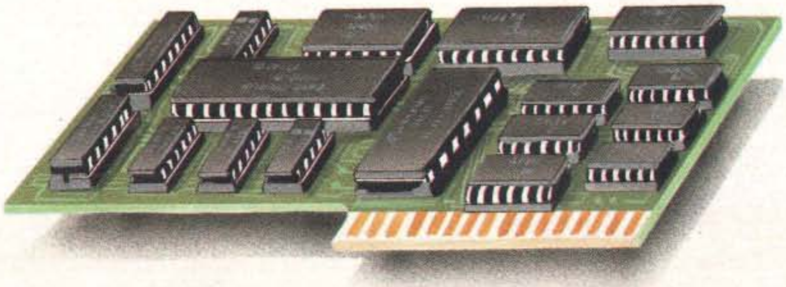

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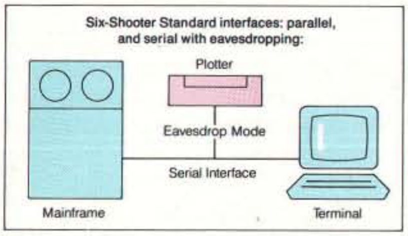
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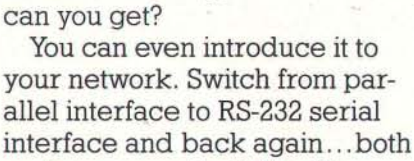

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As for the Six-Shooter itself, you'll find it primed and ready at your nearest computer store. Go for it!

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A mouse with modest requirements

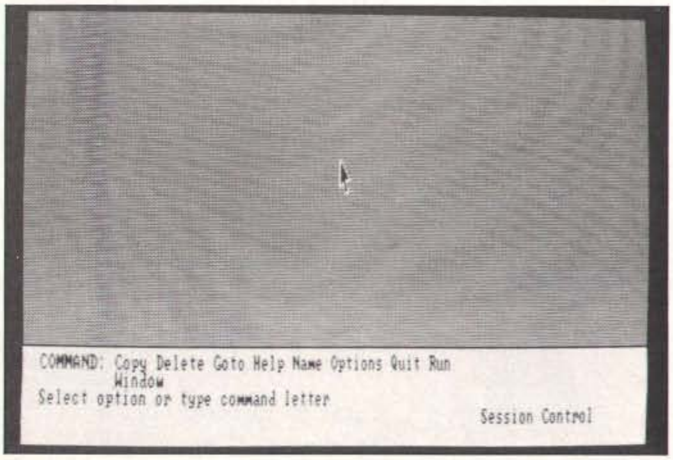
by Phil Lemmons

The desktop metaphor and the mouse present attractive concepts, but Apple's Lisa or IBM's PC XT running Visi On exceeds the budget of the average personal computer user. Both of these systems require a hard disk and great quantities of RAM (random-access read/write memory). Although the mouse itself is a small part of the expense, it is a symbol of this approach to software, and some computer users have been heard to mutter, "What price mice?"

Another factor keeping down the mouse population has been the shortage of things for them to point at (or the shortage of applications software). Until there is a large installed base of Lisa and Visi On systems, many software authors will forgo the expense of developing applications programs for these systems. Prospective buyers of personal computers, on the other hand, are unlikely to buy a Lisa or Visi On until more software is available. Apple's own software for Lisa is magnificent, but other applications programs are only now emerging. Visicorp is making a major effort to induce programmers to write more for Visi On, but the requirement of a Unix development system is an obstacle to the smaller software houses and independent designers. The expense underlying the Unix development system is the hardware required to run it—once again, lots of memory and a hard disk.

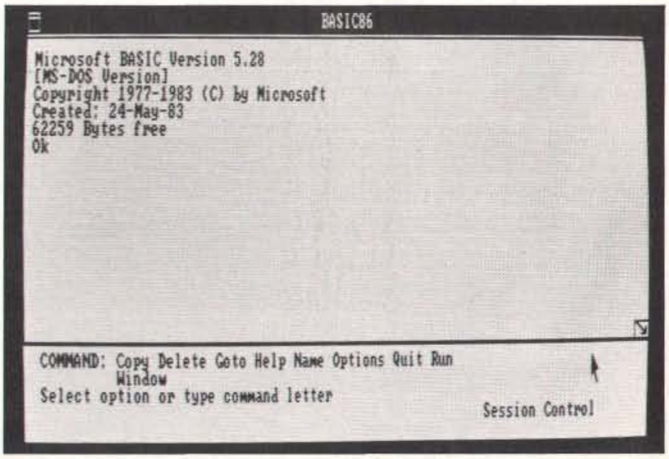
This keeps most of us staring at the MS-DOS or CP/M command line and hoping that a sudden fall in the prices of RAM and hard disks will open the way to metaphors and mice. With the introduction of Microsoft Windows, however, the company that brought us MS-DOS promises a mouse-and-window show running off two 320K-byte floppy disks and 192K bytes of RAM. (More RAM is required, of course, with each additional application.) To make Microsoft Windows even more attractive to personal computer users, Microsoft promises to price Windows "as an operating-system component"—that is, inexpensively.

The economics of Microsoft Windows will also appeal to programmers. Programmers don't need to buy special hardware or to learn Unix in order to develop software that runs under Microsoft Windows —they can use their own IBM Personal Computers. Moreover, programmers can take advantage of the ability to customize windows so that each software house retains its own distinct look within the Microsoft environ-



```
COMMAND: Copy Delete Goto Help Name Options Quit Run
    Window
Select option or type command letter
                                          Session Control
```

Photo 1



```
Microsoft BASIC Version 5.28
[MS-DOS Version]
Copyright 1977-1983 (C) by Microsoft
Created: 24-May-83
62259 Bytes free
Ok
```

```
COMMAND: Copy Delete Goto Help Name Options Quit Run
    Window
Select option or type command letter
                                          Session Control
```

Photo 2

Device-Independent Graphics Output for Microsoft Windows

by John Butler

What makes it possible for Microsoft Windows to output graphics to different devices—printer/plotter devices as well as bit-mapped screens—without changing the graphics code?

Microsoft Windows works with a device-independent graphics system called Graphics Device Interface, or GDI. GDI consists of graphics routines that provide the interface between programs that want to draw images and different output devices. The graphics calls from these programs are not specific to any device. GDI mediates between the graphics calls and the actual devices. The calling program may be an operating-system extension like Microsoft Windows or an application program written in a high-level language.

The design of a device-independent graphics system like GDI begins with the definition of an abstract device. The abstract device is the collection of all the functions that ultimately will be performed by the actual graphics devices. (For example, "draw a circle" or "change hatch style" would be functions for devices to perform.)

When a function is called, GDI takes the function parameters, in abstract-device terms, and passes them to a logical-device driver. A logical-device driver is the software that translates abstract-device functions into a sequence of device-specific actions. These actions (communicated through a physical-device driver) result in the appearance of graphics on the device.

The GDI Abstract Device

The design of the abstract device ultimately determines the types of devices the system can talk to and to what degree the system will be device independent. To define the abstract device for GDI, Microsoft included graphics commands from the current ANSI-VDI (American National Standards Institute-Video Display Interface) standard for drawing on plotting devices. The raster frame-buffer class of device was included by adding the graphics functionality from IBM Personal Computer BASIC. A screen-dump facility and additional raster support provide hard copy and animation capability. GDI's abstract device can support any of the usual graphics subroutine libraries (for example, SIGGRAPH/ACM CORE, ISO GKS, Plot-10) as applications.

The Graphics Primitives

The language of the abstract device is made up of "primitives." The primitives are the calls to the graphics functions available at the lowest level of GDI—the level of the logical-device driver. They are described functionally as follows:

- *Control Primitives. These primitives initialize, terminate, and clear the device.*
- *Output Primitives. These primitives result in the appearance of an actual image on a graphics device. Included are move, mark, polymark, line, polyline, polygon, rectangle, circle, arc, text, and put/get/move bit maps.*
- *Attribute Primitives. These primitives describe something about the appearance of the output primitives. Each output primitive has a set of appearance commands, including size, color, and style. The filled-output primitives (those defining closed areas, such as polygon and circle) take on additional attributes for the color and style of the interior. Attribute primitives are also provided for using color translation tables and doing high-quality text.*
- *Viewing Primitives. These primitives control clipping, relative or absolute coordinates, and absolute sizing of images (to inches or meters). They define the border to which output primitives will be clipped. The viewing primitives also map coordinates from the logical device driver to the physical device driver and from one coordinate space to another, and they set up the resolution of the logical coordinate space.*
- *Inquiry Primitives. These primitives return information to the application program about the current attributes, viewing pipeline, and control flags from the logical-device driver.*

GDI provides a language that application programs can use to create images. An application program can create images without knowing about the characteristics of the output device.

ment. The same enlightened attitude enabled Microsoft to resist the temptation to reserve Windows as an environment for its own applications programs. Microsoft is making Windows available to a number of applications software houses, including some major competitors.

Microsoft Windows is an installable device driver under MS-DOS 2.0 using ordinary MS-DOS files. Complete compatibility with MS-DOS means that Windows will at least let you run any application that runs under MS-DOS. In the worst case, Windows will turn the full display over to an MS-DOS application and return you to your place in Windows. "Language bindings" will enable programmers to write software for Microsoft Windows in any Microsoft programming language.

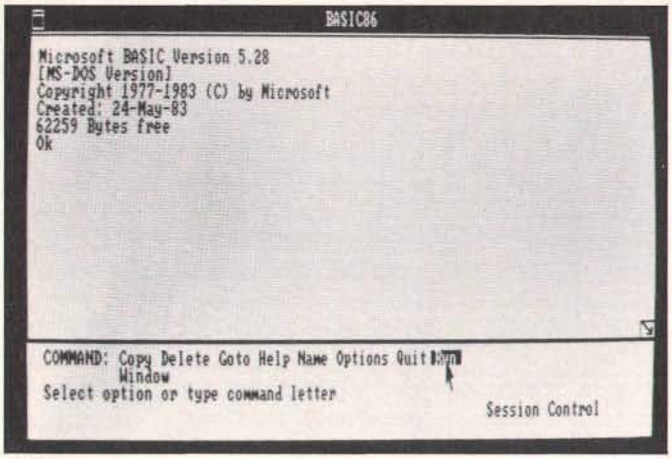
Running Microsoft Windows

Photos 1–13 show a sequence of operations in Microsoft Windows. The photos on pages 52–53 show a variety of machines whose manufacturers have adopted Microsoft Windows as an applications environment.

During normal use, Microsoft Windows displays one or more windows, each with a different application. You can move the cursor from one window to another. You can move windows, change their size, scroll, get help appropriate to the context in which you are working, and transfer data among windows. Windows determines the highest level of data transfer mutually acceptable to the two applications, with plain ASCII (American National Standard Code for Information Interchange) as the last resort.

The "session-control layer" becomes the equivalent of the empty desktop where you can manipulate files. The available commands appear near the bottom of the screen. Normally, Microsoft Windows will restore the desktop to the state at the time of its last use. In photo 1, we start from scratch.

To see the available applications programs, you either use the mouse to position the cursor on the command "Run" or type the letter "R." Windows lists all the applications programs as commands, and you



```
Microsoft BASIC Version 5.28
[MS-DOS Version]
Copyright 1977-1983 (C) by Microsoft
Created: 24-May-83
62259 Bytes free
Ok
```

```
COMMAND: Copy Delete Goto Help Name Options Quit Run
         Window
Select option or type command letter
                                                  Session Control
```

Photo 3

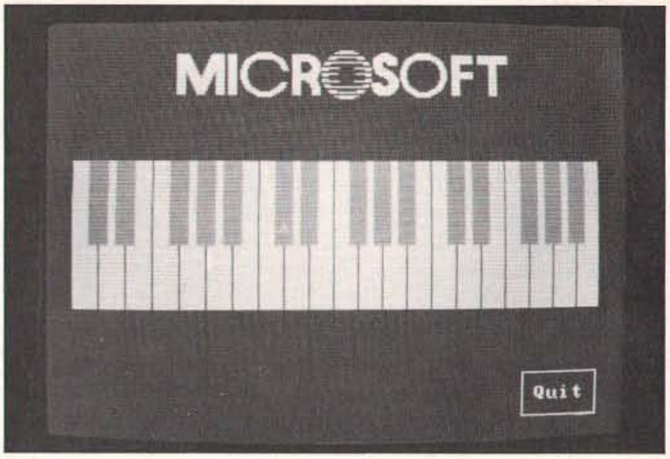


Photo 4

point at the desired program and click the mouse to run it. You could also type the appropriate letter instead.

In photo 2, BASIC 86 is running in a large window extending the full width of the desktop. Because BASIC 86 does all its input/output through MS-DOS, it can run in a Window. Microsoft calls such software "cooperative." The bottom of the screen shows the commands available in the session-control layer. You can use the session-control layer to run another program in parallel with BASIC 86.

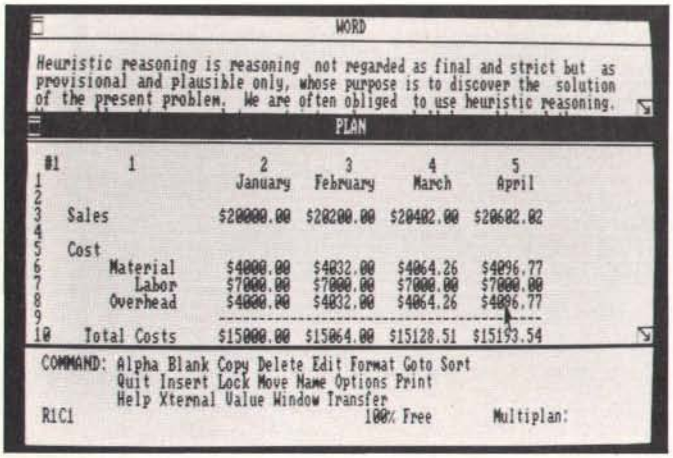
The first step toward running a program is shown in photo 3, where the cursor points at "Run." Microsoft Windows will now display a list of the programs available.

Photo 4 shows the next application selected. In this case, the program that's run is "uncooperative"—that is, it doesn't do everything through MS-DOS system calls, sometimes going beyond the operating system to write directly to hardware addresses such as those of screen memory. Microsoft Windows can't run such a program in a window and must give it the entire screen. That is why photo 4 does not show the session-control layer beneath the display of "Piano."

Certain programs can't use the multiple-window feature.

Photo 5 shows the transition from the uncooperative program to a "smart" one that can live happily in a smaller window and share the screen with other programs that take full advantage of Microsoft Windows. The smart program is Microsoft Word. Photo 6 shows two applications—Word in the upper window and Multiplan in the lower; both these programs were written to take advantage of Microsoft Windows. Because the cursor is pointing at one of the cells in the Multiplan spreadsheet, the command bar at the bottom of the screen shows Multiplan's commands. You can move either window by grabbing its title bar with the mouse. You could "grow" either window by grabbing the "grow box." Although these photos show the title bar at the top of the window and the grow box at the lower right, software developers can put them elsewhere if desired.

(In fact, Microsoft's own standard window has changed since these photos were taken. The latest version provides a question mark on the right

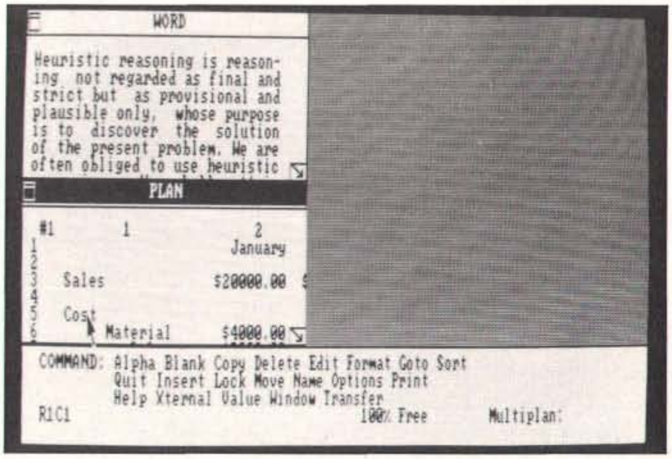


```
Heuristic reasoning is reasoning  not regarded as final and strict but  as
provisional and plausible only, whose purpose is to discover the  solution
of the present problem.  We are often obliged  to use heuristic reasoning.
```

```
 #1        1              2          3          4          5
1                      January    February     March      April
2
3   Sales            $20000.00  $20200.00  $20402.00  $20602.02
4
5   Cost
6        Material     $4000.00   $4032.00   $4064.26   $4096.77
7           Labor     $7000.00   $7000.00   $7000.00   $7000.00
8        Overhead     $4000.00   $4032.00   $4064.26   $4096.77
9                    --------------------------------------------
10    Total Costs    $15000.00  $15064.00  $15128.51  $15193.54
```

```
COMMAND: Alpha Blank Copy Delete Edit Format Goto Sort
         Quit Insert Lock Move Name Options Print
         Help Xternal Value Window Transfer
R1C1                                      100% Free      Multiplan:
```

Photo 7

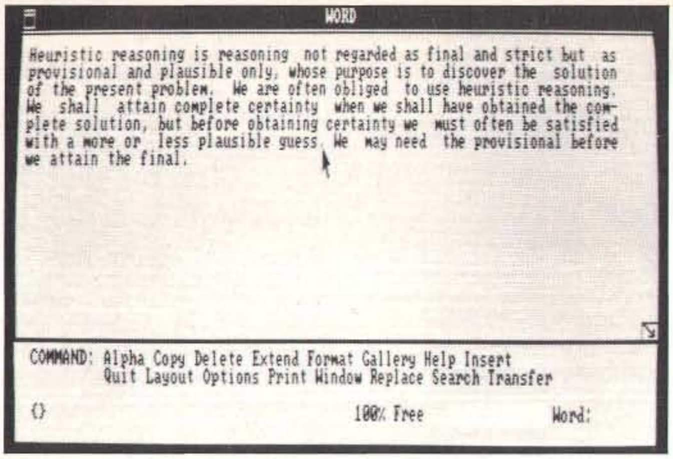


```
Heuristic reasoning is reason-
ing  not regarded as final and
strict but  as provisional and
plausible only,  whose purpose
is to  discover  the  solution
of the present problem. We are
often obliged to use heuristic
```

```
 #1        1              2
1                      January
2
3   Sales             $20000.00
4
5   Cost
6        Material      $4000.00
```

```
COMMAND: Alpha Blank Copy Delete Edit Format Goto Sort
         Quit Insert Lock Move Name Options Print
         Help Xternal Value Window Transfer
R1C1                                      100% Free      Multiplan:
```

Photo 8

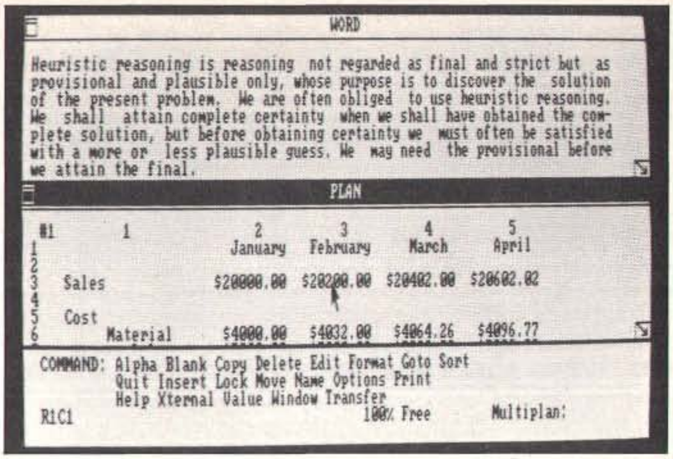


```
WORD
Heuristic reasoning is reasoning  not regarded as final and strict but  as
provisional and plausible only, whose purpose is to discover the  solution
of the present problem.  We are often obliged  to use heuristic reasoning.
We  shall  attain complete certainty  when we shall have obtained the com-
plete solution, but before obtaining certainty we  must often be satisfied
with a more or  less plausible guess. We  may need  the provisional before
we attain the final.

COMMAND: Alpha Copy Delete Extend Format Gallery Help Insert
         Quit Layout Options Print Window Replace Search Transfer

{}                                 100% Free                  Word:
```

Photo 5



```
WORD
Heuristic reasoning is reasoning  not regarded as final and strict but  as
provisional and plausible only, whose purpose is to discover the  solution
of the present problem.  We are often obliged  to use heuristic reasoning.
We  shall  attain complete certainty  when we shall have obtained the com-
plete solution, but before obtaining certainty we  must often be satisfied
with a more or  less plausible guess. We  may need  the provisional before
we attain the final.
PLAN
#1        1              2          3          4          5
1                     January    February     March      April
2
3   Sales            $20000.00  $20200.00  $20402.00  $20602.02
4
5   Cost
6        Material     $4000.00   $4032.00   $4064.26   $4096.77
COMMAND: Alpha Blank Copy Delete Edit Format Goto Sort
         Quit Insert Lock Move Name Options Print
         Help Xternal Value Window Transfer
R1C1                                 100% Free      Multiplan:
```

Photo 6

part of the title bar. Selecting the question mark brings help information. If you put the cursor on the title itself, it is replaced by little pictures that represent what you can do with the window. The new version also includes a status line at the top of the screen and an area for icons at the bottom.)

In photo 7, Multiplan's window has been enlarged to show more cells and more data, and Microsoft Word's window has been reduced as necessary.

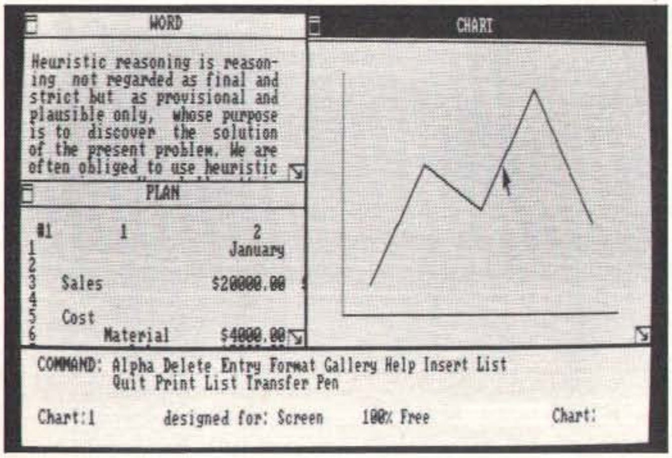
Photo 8 shows both the Multiplan window and the Microsoft Word window reduced. (Since photo 8 was taken, Microsoft Windows has been adapted to use an automatic resizing process called "tiling." Rather than letting windows overlap or leaving part of the desktop empty, Microsoft Windows always gives all the space on the screen to the applications that are running.)

Photo 9 shows a charting program occupying a large window at the right-hand side of the screen. With the cursor in that large window, the command bar at the bottom of the screen lists charting commands. Note that when the window containing the charting program is expanded by moving the title bar and grabbing the grow box, the line graph has been automatically rescaled (see photo 10). Microsoft Windows can rescale graphics if desired.

Microsoft Windows can rescale graphics if desired.

Photo 11 shows a sample "pop up" menu for the charting program. Pointing at the PEN command on the command bar at the bottom of the screen has brought the display of the menu of pen sizes and patterns. You select sizes and patterns by using the mouse to point at one of the boxes shown in each list, then pointing at the "OK" box (see photo 12). As with other aspects of the Microsoft Windows displays, programmers can redesign menus to their own taste.

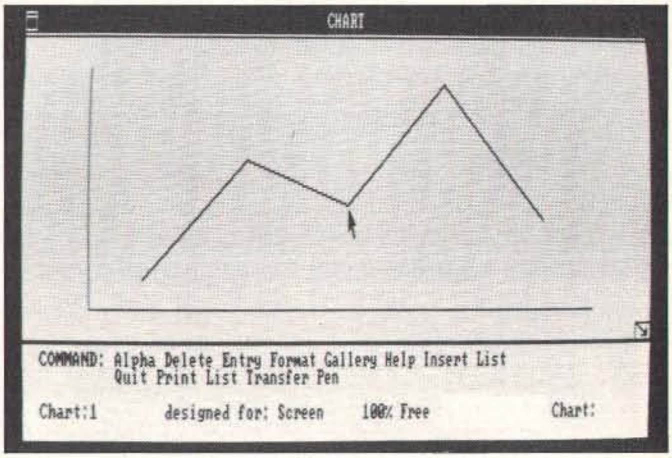
Photo 13 shows the graph displayed in accordance with the instructions entered—with a 4 by 4 pixel-pen size and a gray shading. The graphics capabilities of Microsoft Windows owe much to the device-independent graphics system described by John Butler in the text box "Device-Independent Graphics Output for Microsoft Windows" on page 49.



```
WORD                                 CHART
Heuristic reasoning is reason-
ing  not regarded as final and
strict but  as provisional and
plausible only,  whose purpose
is to  discover  the  solution
of the present problem. We are
often obliged to use heuristic
PLAN
#1        1              2
1                     January
2
3   Sales            $20000.00
4
5   Cost
6        Material     $4000.00
COMMAND: Alpha Delete Entry Format Gallery Help Insert List
         Quit Print List Transfer Pen

Chart:1        designed for: Screen    100% Free             Chart:
```

Photo 9



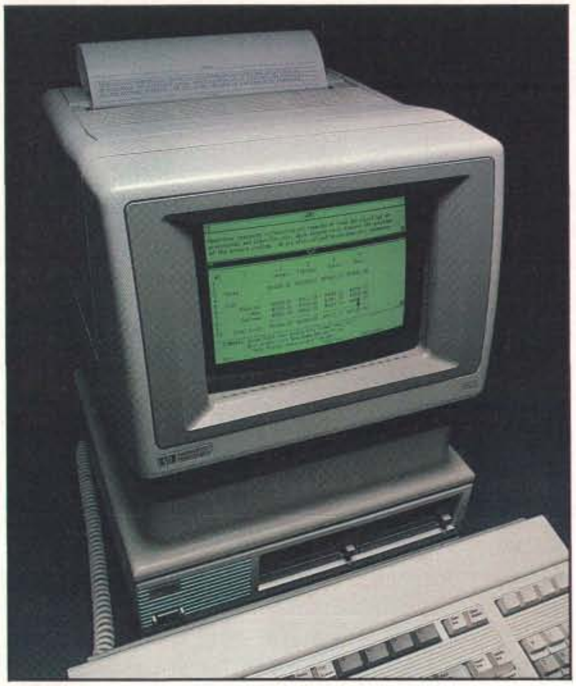
```
CHART

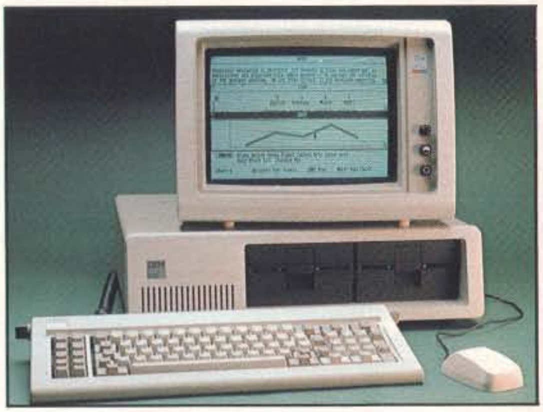
COMMAND: Alpha Delete Entry Format Gallery Help Insert List
         Quit Print List Transfer Pen

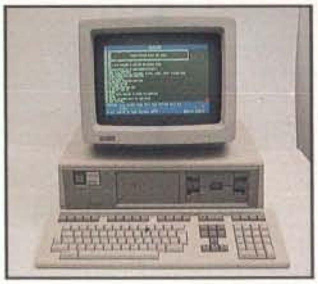
Chart:1        designed for: Screen    100% Free             Chart:
```

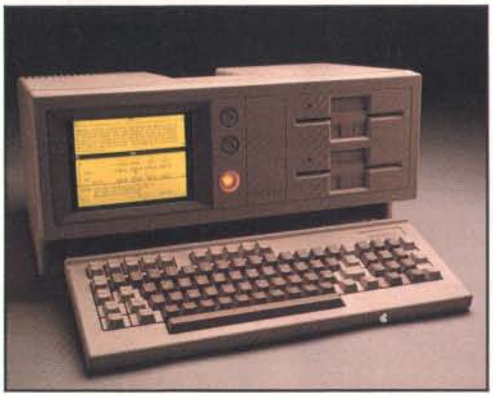
Photo 10

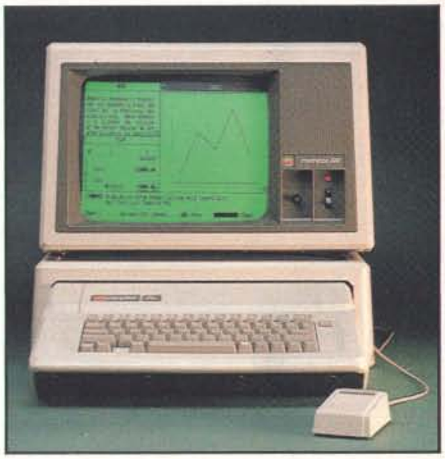
Some machines that run Microsoft Windows

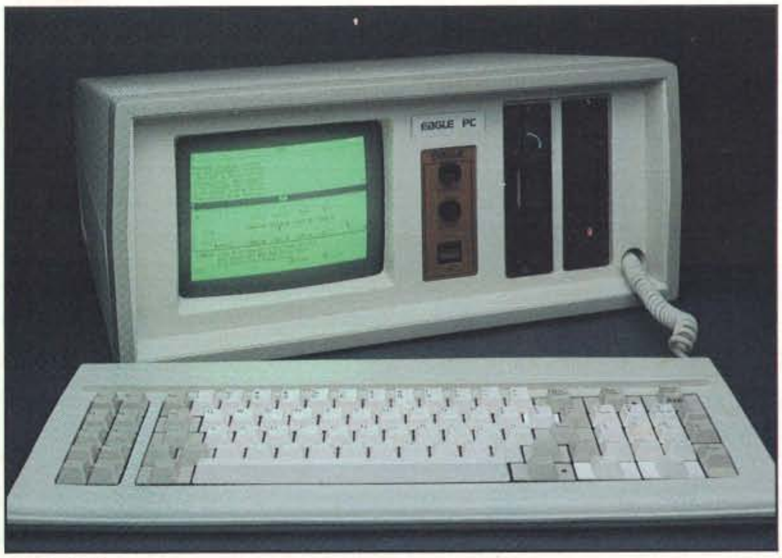

Hewlett-Packard 150


IBM
Personal
Computer

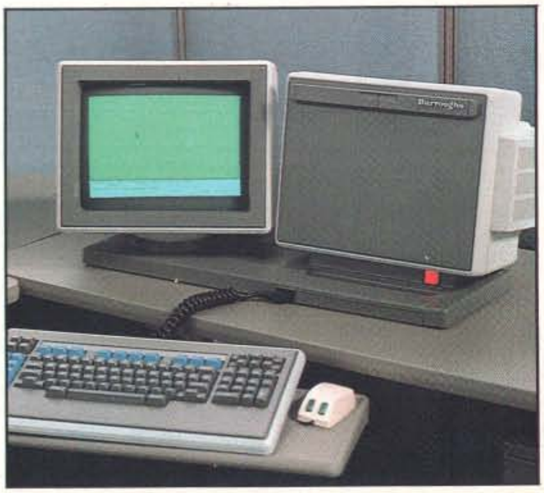

DEC
Rainbow 100


Bytec
Hyperion

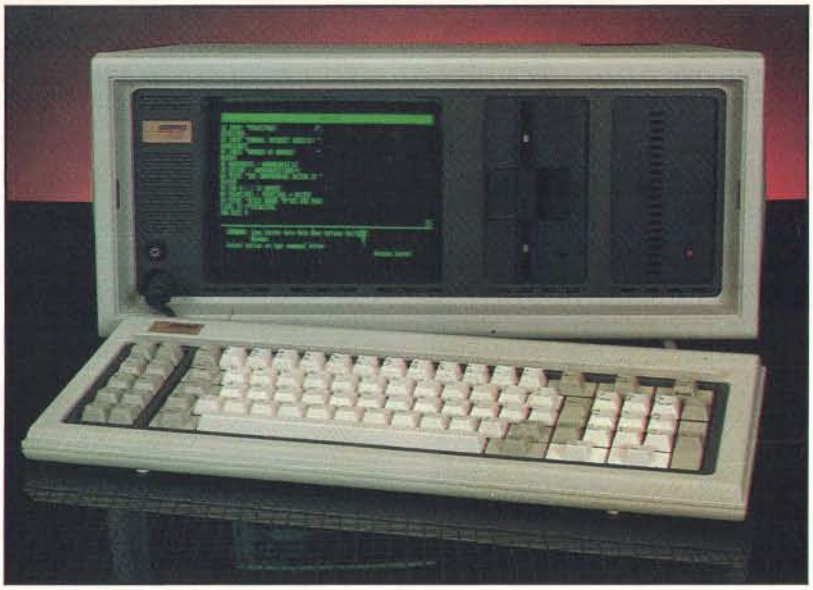

Apple IIe/
Rana Drive
System
with 8086



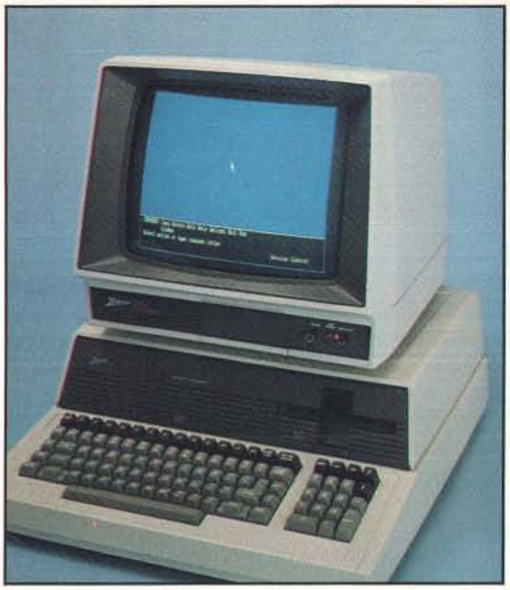
Eagle PC



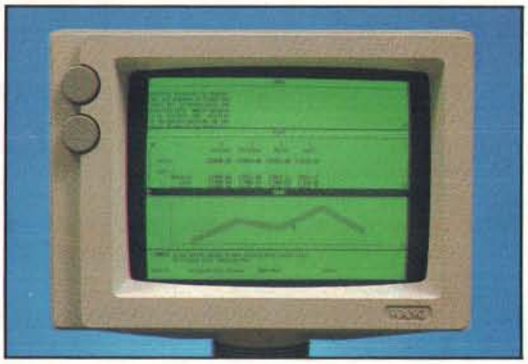
Burroughs B20



Compaq Portable

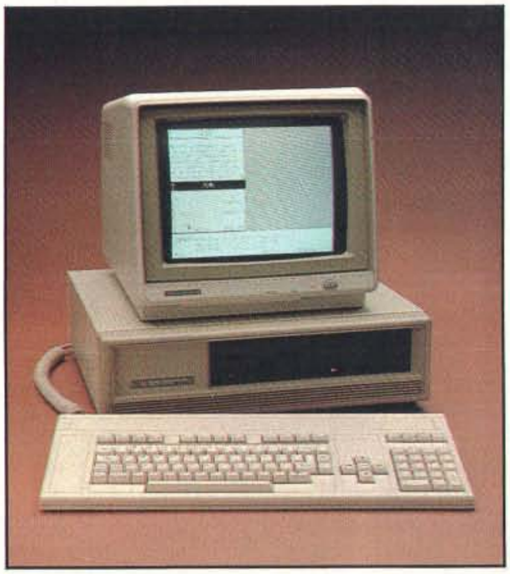


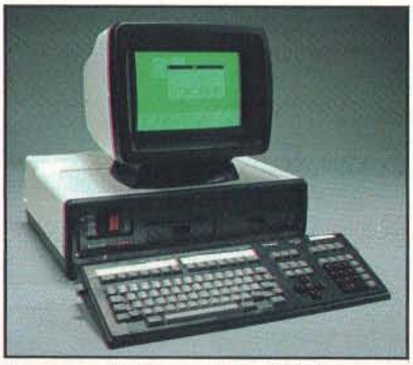
Zenith Z-100



Wang
Professional
Computer

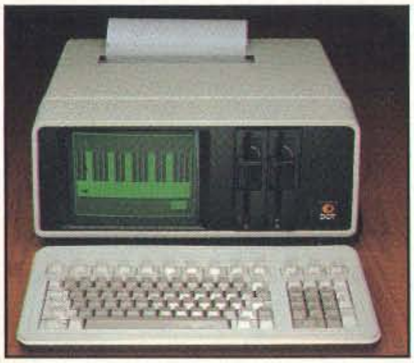
Texas
Instruments
Professional
Computer



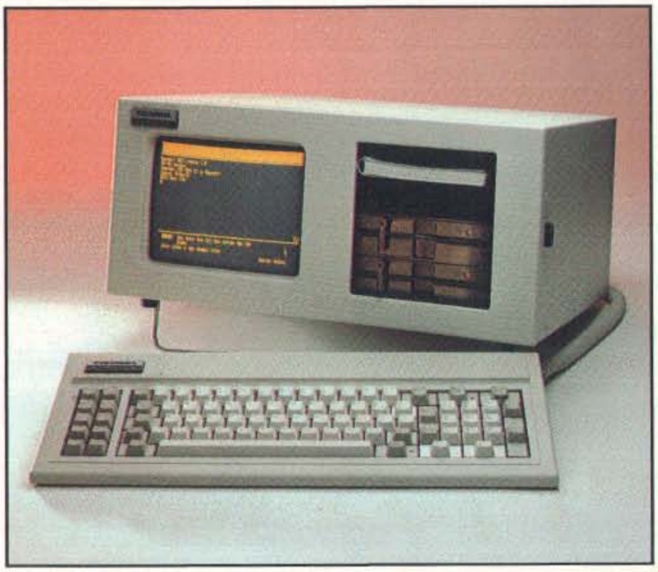


Honeywell Microsystem 6/10

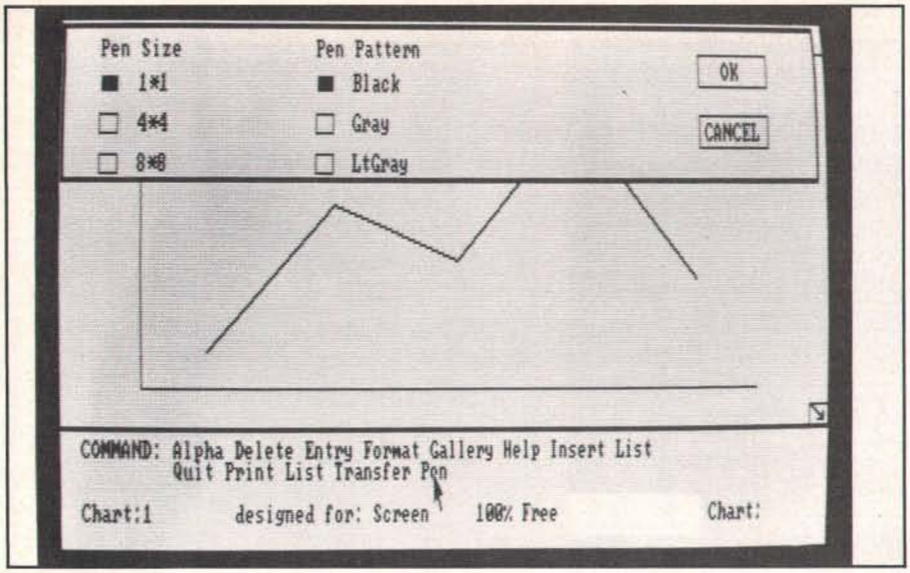
A package from Radio Shack, not to be opened before December 1



Computer
Devices
Dot



Columbia
Data Products
MPC Portable

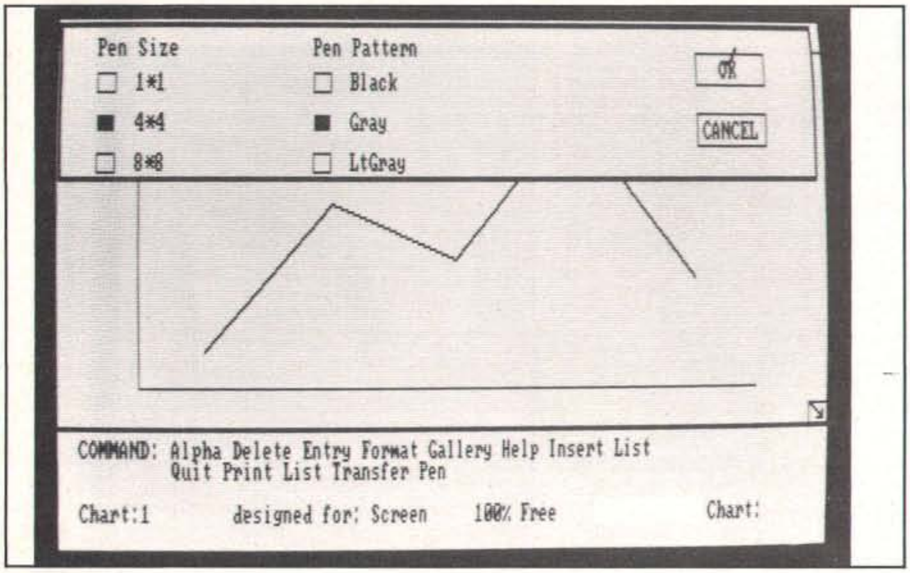


Pen Size	Pen Pattern
■ 1*1	■ Black
☐ 4*4	☐ Gray
☐ 8*8	☐ LtGray

OK
CANCEL
COMMAND: Alpha Delete Entry Format Gallery Help Insert List
Quit Print List Transfer Pen

Chart:1 designed for: Screen 100% Free Chart:

Photo 11



Pen Size	Pen Pattern
☐ 1*1	☐ Black
■ 4*4	■ Gray
☐ 8*8	☐ LtGray

OK
CANCEL
COMMAND: Alpha Delete Entry Format Gallery Help Insert List
Quit Print List Transfer Pen

Chart:1 designed for: Screen 100% Free Chart:

Photo 12

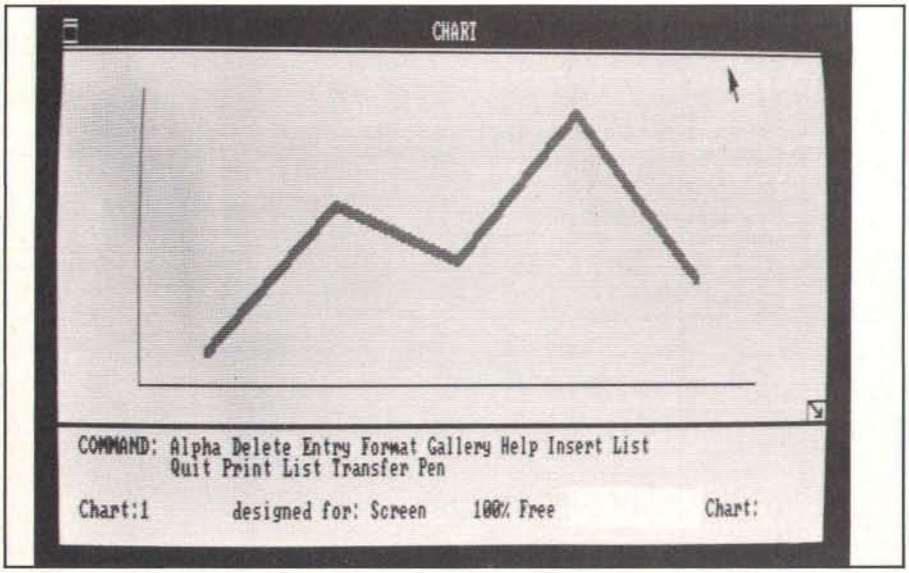


CHART
COMMAND: Alpha Delete Entry Format Gallery Help Insert List
Quit Print List Transfer Pen

Chart:1 designed for: Screen 100% Free Chart:

Photo 13

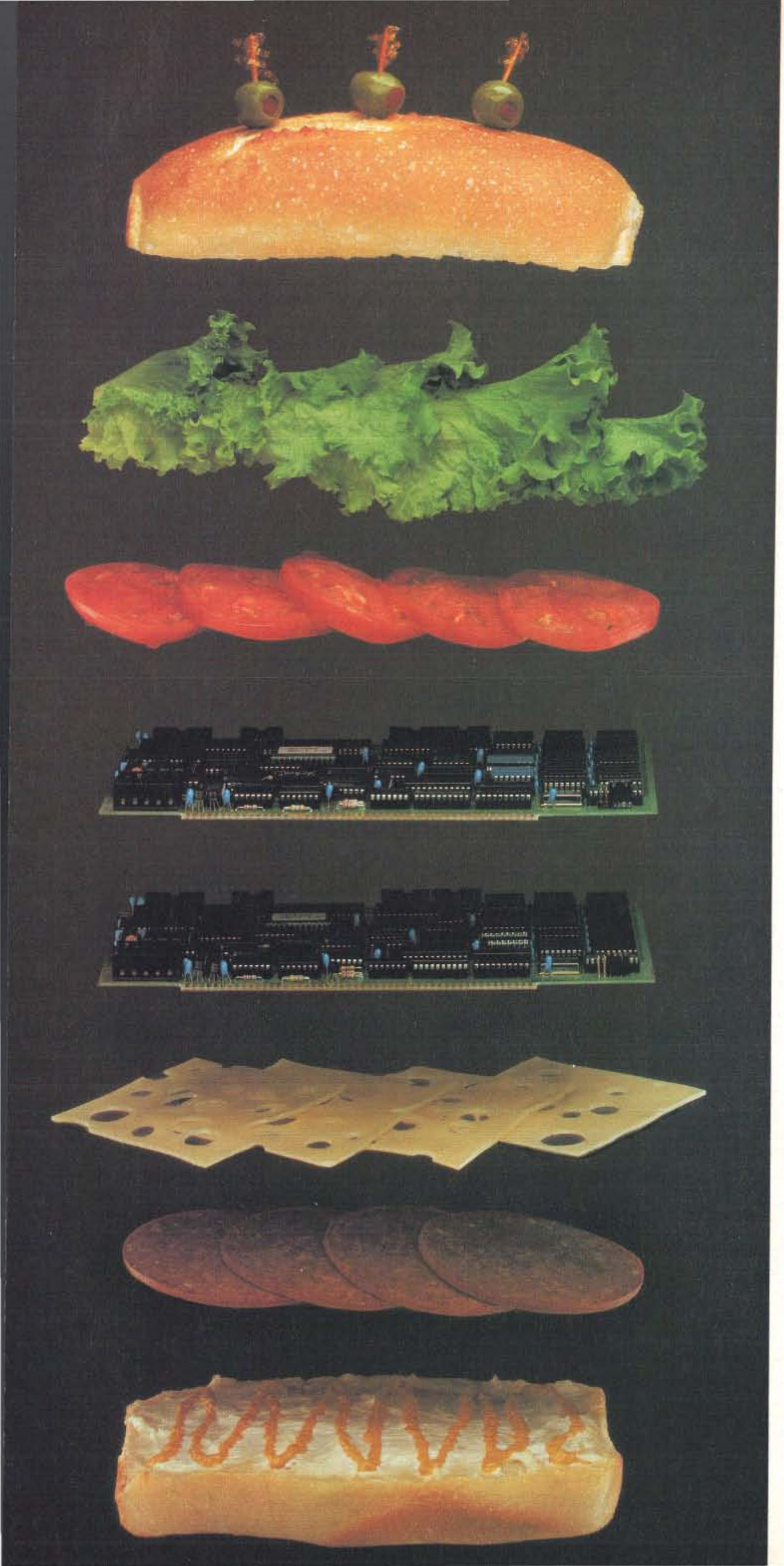
Conclusions

Microsoft Windows seems to offer remarkable openness, reconfigurability, and transportability as well as modest hardware requirements and pricing. As a result, the desktop metaphor and mouse, intended to bring computing power to nontechnical people, are finally going to reach the hands of many such people. Barring a surprise product introduction from another company, Microsoft Windows will be the first large-scale test of the desktop metaphor in the hands of its intended users.

It is natural to wonder whether Microsoft Windows' ability to run in limited memory and off floppy disks will result in noticeable delays during execution. Even Lisa with its megabyte of memory and 68000 microprocessor frequently asks the user to wait. Is the ease of use worth the waiting? Will Microsoft Windows somehow ingeniously avoid the problem of delays? The answers to these questions will shape the future of mass-market software.

The open approach and the presentation of Microsoft Windows as an extension of MS-DOS 2.0 will help attract the horde of programmers necessary to assure acceptable execution speeds on the IBM PC. Just as enough programmers working long enough on enough different approaches have made the Apple II perform feats that once seemed incredible, enough programmers working long enough on different approaches will make applications run fast under Microsoft Windows on ordinary hardware. Even if this judgment proves mistaken, Microsoft's policy of openness and low pricing will have made possible a major experiment in mass-market software. For many software authors as well as users, this will be the first chance to test an approach to the user interface that has hovered just beyond reach for several years.■

Phil Lemmons, BYTE's West Coast Bureau Chief, can be reached at McGraw-Hill, 425 Battery St., San Francisco, CA 94111.



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User's Column

Buddy, Can You Spare a Door Latch?

A lack of spare parts almost causes a crisis at Chaos Manor

by Jerry Pournelle

My summer has been devoured by locusts. It's gone, and I don't know where it went. Actually, I do: it wasn't locusts, but our new novel *Footfall* (Larry Niven and Jerry Pournelle, Ballantine Books, January 1985) that ate my summer; so now I sit here writing this column while everyone else in the world is in San Francisco for the first IBM PC Faire.

I suppose it doesn't matter: although we ordered it two months ago, our IBM PC hasn't arrived. Since there's a ton of unreviewed PC software glaring balefully at me from the far corner of the office, it would be beyond reason to collect more until the machine arrives.

I confess we're looking forward to the machine. I already have a number of ideas for upgrading it, and I hope to test a bunch of expansion boards for it.

Then, too, Mrs. Roberta Pournelle has written a book on using computers to teach young and/or educationally handicapped children to read, and we plan to do the first implementation on the IBM PC, so we're eager to get started. Once we have it for the PC, we'd like to get it running on the TI-99 (because it's a cheaper machine, and has a voice synthesizer already integrated to it, so more schools would be able to make use of her teaching system at lower costs), but, alas, our efforts to find reasonable programming languages for the TI have failed.

Logitech's Modula-2 compiler works on nearly any machine running CP/M-86.

Anyway, that's for the future.

Flash

The American Society for Computers in Medicine and Dentistry will hold a meeting at Honolulu's Sheraton Waikiki Hotel from January 4-8, 1984. Speakers will include myself, Dr. Larry Weed, whose "diagnostic programs" have impressed me tremendously, and Marvin Minsky of the MIT Artificial Intelligence Laboratory.

Anyone interested should write Dr. John S. McDonald, President, ASCMD, POB 21483, Upper Arlington, OH 43221, (614) 421-8487. The ASCMD is a nonprofit professional society.

Hot Tip

I've heard from three sources now that Digital Research is no longer supporting CP/NET. It claims it will have something to replace it Real Soon Now. The company has also abandoned several previously announced modules of GSX, its graphics support package that was announced with such fanfare at Comdex last spring. This has not amused several equipment manufacturers who'd invested considerable time in CP/NET and/or GSX.

Modula-2!

We're running Logitech's Modula-2 compiler. It works on the Eagle, the IBM PC, and nearly any other machine that runs CP/M-86. It comes with System and Terminal modules (including source code) that allow it to adapt to whatever you're running;

the latest version I have is for the Compupro 8085/8088.

Because of the pressure of our novel, I've done little more than play with the compiler. That changes as soon as this book is done. I intend to write some serious code in Modula-2.

The Logitech Modula-2 compiler works. On the other hand, you'd better be a Modula-2 enthusiast. This is still a language implementation under development, and it lacks a lot of conveniences. The documents need work, too. No matter, if you're bent on getting Modula-2 *now*, as I am; but fair warning if you're a casual user.

Understand, the compiler works. There are some significant limitations. No type REAL numbers yet, and no overflow and range checking code. Priorities in modules are not yet implemented—you can program them in, but they're ignored. These are not severe limits for the first version of a compiler, and they'll be corrected soon anyway, mostly before you read this. (Type REAL, based on the 8087 chip for terrific speed, will be available as a test version in December and for general sale in February.)

The documents are very rough. There's no index, and no tutorial on how to use Modula-2. You have to rely on Wirth's book, *Programming in Modula-2*, and that's nearly unreadable. I'd like to do a good book on Modula-2 myself; I'd rather have one to read than have to write it, but I'm beginning to despair. However, Logitech's documents are good enough if you know something of what you're doing—for example, if you're somewhat used to C or Pascal on microcomputers.

Modula-2 is still a language implementation under development, and it lacks a lot of conveniences. The documents need work, too.

There is, for instance, a simple walk-through for getting "MyProgram" written, saved, compiled, and operating. Given that example, you can build up to more elaborate levels.

I say the Logitech package is a bit rough, but it's a little hard to give specific problems, because as fast as they're found, Logitech fixes them. The company has been really responsive to user reports. Moreover, many problems aren't all that severe. For example, the documents say that if you compile a source file, the compiler looks for a default of type .MOD (that is, if you don't specify a filename extent, the compiler assumes one of .MOD); in fact, though, it doesn't assume any such thing, and you must type in FILENAME.MOD, which is annoying although hardly fatal.

The compiler is pretty slow, too; it takes four passes at the code, and there's no precompiler to find trivial errors (such as undeclared variables and missing semicolons). However,

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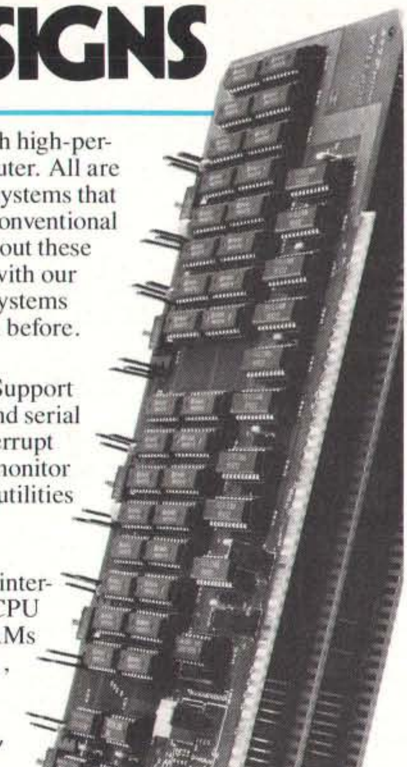

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Pierluigi Zappacosta, president of Logitech, tells me that in the past week (August 22-26) it has improved the speed of the CP/M-86 compiler by 20 percent.

Logitech has also identified a number of small but important improvements that ought to be made to the language itself. Logitech, Volition Systems, and Diser Inc., the three U.S. publishers of Modula-2, have agreed on a set of changes and hope to persuade Niklaus Wirth, Modula-2's inventor, to approve them. They're not major, but they will make life a lot easier for programmers. One change is type LONG INTEGER, so that you can handle really big numbers. Another is the ability to build a string by concatenating characters one at a time; at the moment, string handling is a bit awkward.

Late addition: Wirth's comment is that industry needs standards more than academia, and he won't oppose the proposed extensions.

Logitech is also working on a text editor that will be integrated with the compiler, much as the editor is integrated into the compiler in Digital Research's Speed Programming Package addition to its Pascal MT+. Modula-2 badly needs that feature.

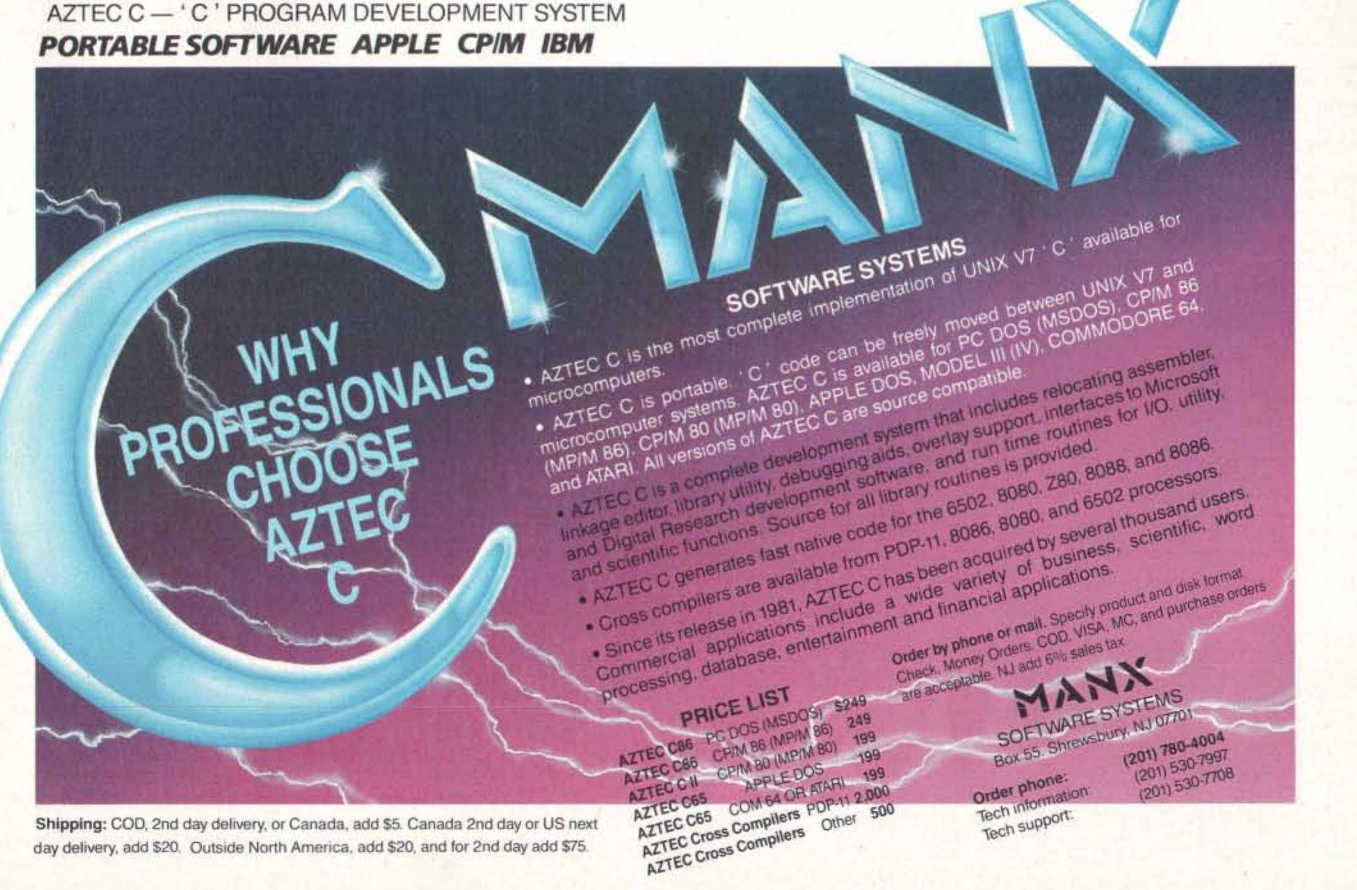
It also badly needs a precompiler. That is: Modula-2 is case sensitive. All the reserved words (such as DO and WHILE and END) must be in uppercase letters. In addition, variable and function names are case sensitive. The new-line function is WriteLn and it must be written that way; Writeln or WRITELN won't do. That's not a bug, it's a feature. It's not a feature whose value is self-evident, although I'm beginning to understand its purpose. In any event, I'm writing a kind of precompiler, a sort of very primitive cousin of the C language's *lint*, which will look for silly errors such as missing semicolons, and also check for reserved words in the wrong case, and WriteLn and WriteString not spelled funny, and such like. Writing it is instructive: it's really a simple thing to do, and adding features to the program turns out to be very easy. Obviously I'm writing the program in Modula-2.

There's a whole lot to like about the Logitech implementation of Modula-2. For example, the company gives the source code for the Terminal and System modules, as well as a whole bunch of others. The library is quite extensive.

Despite my enthusiasm, I don't advise beginning programmers to buy Logitech Modula-2 for their CP/M-86 or IBM PC-DOS systems just yet. Wait a couple of months until it gets the bugs out.

You should also give Logitech a chance to polish up its documents. It's worth half your sanity to try to figure out how to open, close, read from, and write to CP/M files. The information is all there, in comments in the source code for the Library module FileSystem; but, alas, there are *no examples*, which almost drove me nuts when I tried actually to *use* the code.

Again, Logitech assures me it's dancing as fast as it can, and it takes my suggestions seriously; it recently hired document consultants to help improve documentation. Still, begin-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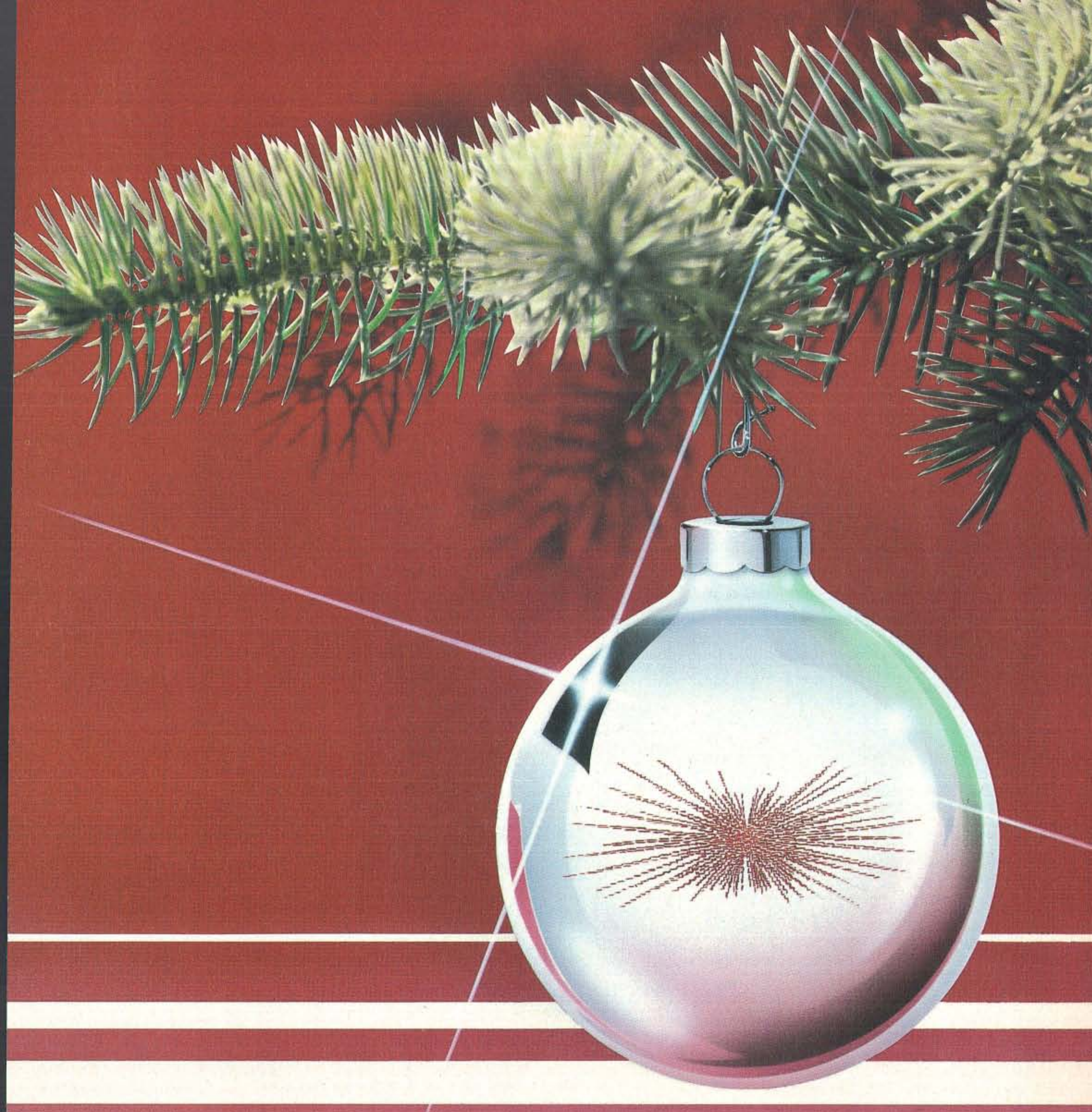

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ners should be wary.

On the other hand, there's no reason for experienced programmers to wait. If you're used to writing Pascal programs and you're interested in Modula-2, I recommend the Logitech implementation. If you like Pascal MT+, you'll love Modula-2.

More Modula-2

The Logitech Modula-2 system generates native code (makes .CMD command programs) for machines running CP/M-86 and IBM PC-DOS, and is the only Modula-2 implementation I know of for machines with those operating systems.

There's another Modula-2. Volition Systems publishes Modula-2 for machines using the UCSD Pascal operating system. The two I know about are for Apple UCSD Pascal and the Sage, but I have a press release announcing it for the IBM PC, complete with operating system, editor, tutorial programs, and lots of utility programs. I should have the PC version about the time I get my PC.

Unlike Logitech Modula-2, Volition Systems Modula-2 generates an intermediate p-code (as does UCSD Pascal). Volition is currently working on a Modula-2 compiler to produce native code for the 68000 chip to operate under CP/M-68K. Volition promises to have that Real Soon Now. It ought to be significantly faster than its p-code implementation.

I haven't yet run competitive tests of Volition vs. Logitech Modula-2, although I know beforehand that Logitech's will be considerably faster (because it's native code). On the other hand, the current Volition documents are incomparably better than Logitech's. You can use the Volition documents to learn a lot about Modula-2. Oddly enough, though, the Volition documents are missing one *vital* ingredient: there's no walk-through for writing, saving, and compiling a simple program, and it turns out to be darned hard to puzzle out how that's done.

Indeed, I learned most of what I know about Modula-2, and caught my enthusiasm for the language, from the Volition Systems people.

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The documents can be improved, but they're pretty good.

Me, I'm glad to have Modula-2 on two of my advanced machines, and I can hardly wait for the CP/M-68K version. I expect it's pretty obvious that I really like the language.

Zipping Up Your Z-100

Zorro the Z-100 has become a permanent fixture here. We like his color graphics a lot. For those few who don't know, the Zenith Z-100 is a dual-processor machine, with both 8085 (8-bit) and 8088 (16-bit) central processing unit chips. On the 16-bit side, it runs Z-DOS which is virtually indistinguishable from IBM PC-DOS; the 8-bit side runs standard CP/M 2.2*x*. We have WRITE, our favorite text editor (see below), running on the Z-100.

There is also the H-100, which is the Heathkit version of the Zenith Data Systems Z-100. A number of readers have written in to recommend getting a Z-100 that way. I don't myself have firsthand experience with the kit, but James Ransom, an L-5 Society associate and friend, recently put one together. He'd never built a large kit of any kind before.

Jim got his machine on Friday afternoon and had it running by Saturday night; and as I said, he's not at all experienced in kit building. So far as we can tell, the machine runs fine, and he saved a real bundle by building it.

In fact, there's not a lot to build. You do have to solder the disk-controller card. The Z-100 is an S-100-bus machine although the computer and its video driver are on a single nonbus card; the disk controller is a separate card, and thus easy to work on. The computer and video components are already assembled and tested.

Except for soldering the disk controller, building the kit consists largely of assembling the prewired parts and in general bolting things together.

Jim Ransom reports that not only did he save money, but he's got a better understanding of how his machine works. If that weren't enough, the two volumes of technical manuals for the Z-100, which normally sell for $55, come free with the kit.

More Brain Cells

Heath/Zenith sells the Z-100 with a standard 128K bytes of memory. There are slots on board the machine for adding an additional 64K bytes. The Heath memory upgrade kit lists for $165, and consists of the memory chips and instructions on how to disassemble the machine and install the chips.

If you buy the kit version, you can get the memory expansion kit for half price, or $82.50, but that's not really a very good deal, because in fact there's no earthly reason why you'd want to pay that much. You can buy the chips for less, and certainly the kit builder knows how to take the machine apart.

In fact, any moderately intelligent user can upgrade a Z-100. Understand, I assume no responsibility for your success. I only report that I was able to do mine—and indeed I had an avoidable problem, which I'll detail below. If you decide to do your own, thus saving about $100, you do it at your own risk, and don't blame me if it doesn't work well.

The only tool needed is a hex-nut driver, available in most hardware stores for a dollar or so. It takes a bit of thought to determine exactly how to take the machine apart, but in fact the relentless application of logic will do the job.

You'll also need the memory chips, of course. They're 4164 64K-bit dynamic-memory chips. I got mine from California Digital for $6.95 each. I didn't have the instructions when I first conceived this scheme, and bought only eight of the chips, which seemed reasonable—we were adding 64K bytes of 8-bit memory, so eight 64K-bit chips ought to do it, right? Wrong, of course, because the Z-100, like most other 16-bit machines, does parity checking on the memory, and thus needs an additional 64K bytes (by 1 bit) of memory. Thus you need *nine* of the 4164 chips. If you're a worrier, get 10 so you'll have a spare in case you do something awful.

Incidentally, I recommend California Digital as a good source of chips,

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fans, disks, small parts, and general computer hardware parts. The company is courteous, very efficient, ships the same day you order (if you give a credit card number), and is willing to answer fairly stupid questions. (My stupid question came about because I got eight chips, then had to order another; the new one didn't look like the other eight. It wasn't made by the same outfit and didn't have the same numbers. California Digital's people assured me they were the same, as indeed they turned out to be.)

Once you have the chips, you need to take the Z-100 apart. This involves removing the cover, then removing six hex nuts, two of which are topped by the posts that help lock the cover on. Once that's done, the two disk drives and their mounting bracket lift out as a unit. You have to disconnect the cables; make a note of how they were oriented *before* you disconnect them. There are two cables to each disk drive: a flat data cable and a power cable. Each comes off by simple pulling, but don't yank. Be gentle; data cables aren't especially delicate, but you can pull them apart if you're too rough.

Take the disk drives completely out and lay them down carefully. This will expose some more screws that hold on the rest of the machine's case; you also take out the other two locking pins that held the upper part of the case on. Lift off the case. That exposes the keyboard, which simply lifts off—it's not even screwed down. Be careful of the keyboard cables. Don't disconnect them, just set the keyboard, still attached, on the table in front of the machine. The cables are long enough.

Now remove three screws that hold the video board on and tilt it back. You need not—and should not—disconnect anything here either; the cables are long enough.

You'll see nine empty chip sockets, eight right together and a ninth just below and slightly off to one side. They're marked U-137 through U-145, and you can't miss them.

If you bought your chips from California Digital, they arrived in a black sticky foam thing that protects them from static damage. Before taking them out of that, *ground yourself* and take a lot of precautions about static electricity. Everyone I know warns me about how easy it is to destroy these chips.

Once the chip is removed from the protective foam, *do not* lay the IC down or let go of it until it is installed in its socket. If you need to bend the IC pins (you probably will), hold the chip in one hand, use a metallic work surface (such as the bottom of the Z-100 case), and touch the metal surface with the other hand before touching the chip to the surface.

IC leads are often splayed, and need to be bent perpendicular to the chip before the chip can be inserted. The ones I got from California Digital didn't need that, but it's best to anticipate.

Be sure to put the chips in the right way, which is to say with the little notch in the same direction as the little notches are on all the other chips on the board. If you get one in backward, that chip is *gone*. Get the chips

Text continued on page 72

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```
10 LET X=LOG(2250/5)*SQR(267.93198#)
20 LET Y=EXP(4)/3.639876700000002#
30 LET Z=(6233+328)^.5
40 LET K=(X-Y-Z)
50 PRINT CINT(K)
Ok
RUN
 4
Ok
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puter companies ask you to pay extra for features like these. Most can not offer them at any price.

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The satisfying silence of the slim, Epson-designed disk-drives is one way for you to judge or, for an inside-out perspective, here is an excerpt from a review by Jim Hanson in the April, 1983 issue of *Microcomputing*.*

"The Epson QX-10 is soundly designed and executed. I looked hard and found no evidence of kludging or shorting out anything in the name of economy. All the connectors have gold on them and are of quality manufacture. The printed circuit boards are heavy, with soldermarks on both sides of double-sided boards. The circuit boards are completely silk-screened with component labels, and the layout is as professional and clean as you will find anywhere."

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EPSON
STATE-OF-THE-ART...SIMPLICITY.

Text continued from page 68:

in properly, making sure that every pin is in a socket. Inspect it with a strong flashlight.

Then put the machine back together, fire up Z-DOS, and run the MEMTST. If you get memory errors, it's likely a chip was improperly installed. We did, and it was easily fixable. The result is a 192K-byte system.

Megabyte, Anyone?

Of course if you're a *real* memory fanatic, you can install a Macrotech *1-megabyte* memory board. Alas, there's not much software to make use of that much memory for the Z-100 because it doesn't (yet) run CP/M-86. It's also nontrivial to figure out how to get your Macrotech megabyte board running in a Z-100 from just the Macrotech documents.

You can install the Macrotech megabyte board in most S-100 systems. If you're running CP/M 2.2, only the first 64K bytes of that memory is available as work space, but the rest can be configured as a "virtual disk," i.e., the machine can be fooled into thinking that's a very fast disk drive. If you've read previous columns, you'll know I'm a believer in virtual disks.

To the best of my calculations, Macrotech's huge boards provide the lowest cost per kilobyte of memory. In the old days we all insisted on static rather than dynamic memory, because dynamic memory wasn't reliable. Really conservative designers still think that way, but dynamic is getting more and more converts, and it sure costs a lot less.

Do We Care?

While we were taking the Z-100 apart, we managed to break one of the disk-drive door latches. I'm not sure how it happened. On the other hand, once it was broken and we'd taken the drive apart to examine it, I couldn't understand why it never broke before. That's a very poor design.

In any event, my $300 drive was disabled for want of about a dime's worth of plastic. To make the disaster worse, Mrs. Pournelle's book was on Z-100 disks, and there was no way to access it until we got Zorro fixed. Needless to say, she was not pleased with me.

My first thought was glue, but I've never had much luck with those super glues, and didn't this time; all I managed to do was waste an hour or so. However, the drive latch is a simple mechanism, obviously easily replaced (I'd taken it off to try to glue it), so all I needed was a new plastic part.

First call was to the local Heath store. No spare parts for disk drives. No idea of where to get them. Indeed, they didn't even know these were Tandon drives. (See photo 1.)

Second call to California Digital. No spare parts. Priority One, ditto. Both referred me to Tandon.

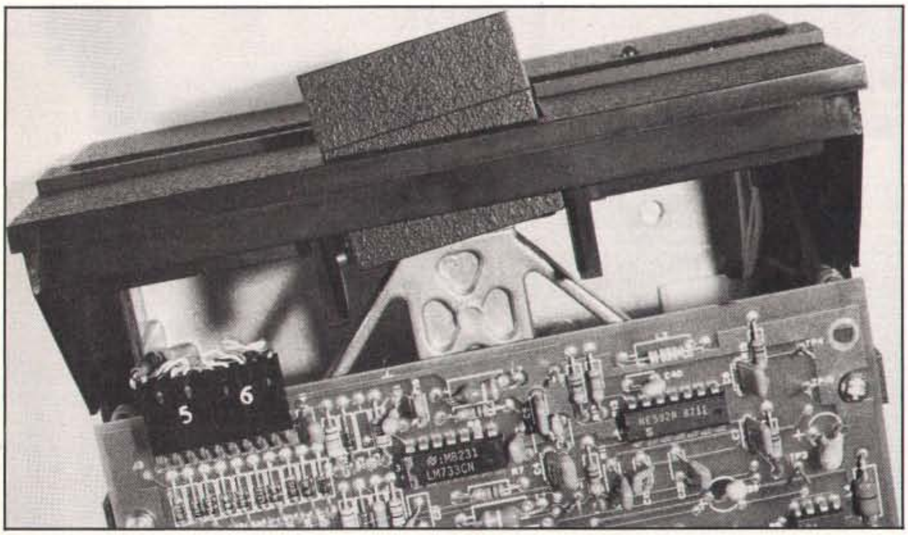

Photo 1: *On the same day Jerry's manuscript arrived at BYTE, the door pins broke on one of our Tandon floppy-disk drives.*

Next day came. Roberta was getting icily polite. Time to Do Something, so I called Tandon and asked for the Director of Marketing.

Tandon is a big outfit, and it took about four levels of switchboards and secretaries before I got someone. He was very polite. I explained that I had two problems. One was acute, namely getting a vital but trivially cheap spare part; the other was more to the point, namely that I was acquiring an IBM PC, and it might be interesting to discuss how one might use Tandon drives to expand the PC's capabilities.

It turned out that I had the wrong man. My very polite contact told me he'd find the proper person from Product Support who'd call me. Moreover, he recognized my desperation, and would have someone call *soon*. I expect he could hear my sigh of relief all the way from Hollywood to the Tandon factory out in the northwest San Fernando Valley.

The call did come soon. This time the caller sounded as if he were at the bottom of a well; I presume he was using a telephone amplifier. I'm partly deaf, and I never did get the name properly. In any event, I had an enlightening conversation. First he gave his name. He already knew mine, and knew what I wanted.

Next he asked if I understood the computer industry. When I professed not to understand the question, he asked it again. "Do you understand the computer industry?"

"I really don't know what the question means."

"Do you understand the computer industry?"

By now it was obvious that I was in an endless loop, and I needed a Control-C, so I said, "I think so."

"I don't think you do."

This didn't seem a very good way to begin a relationship, but I wasn't sure what to do about it.

He proceeded to explain that Tandon is an OEM supplier. "We ship 200,000 drives a month. Your source was Zenith. You should ask Zenith."

I remembered when we put the late Ezekial I together. Zeke used iCOM disk drives, and when I had problems I called the company; an engineer explained precisely what I

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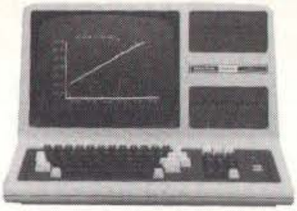
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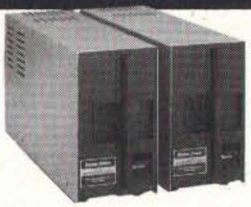
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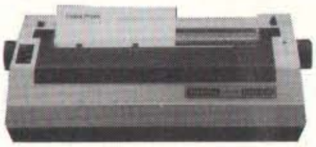
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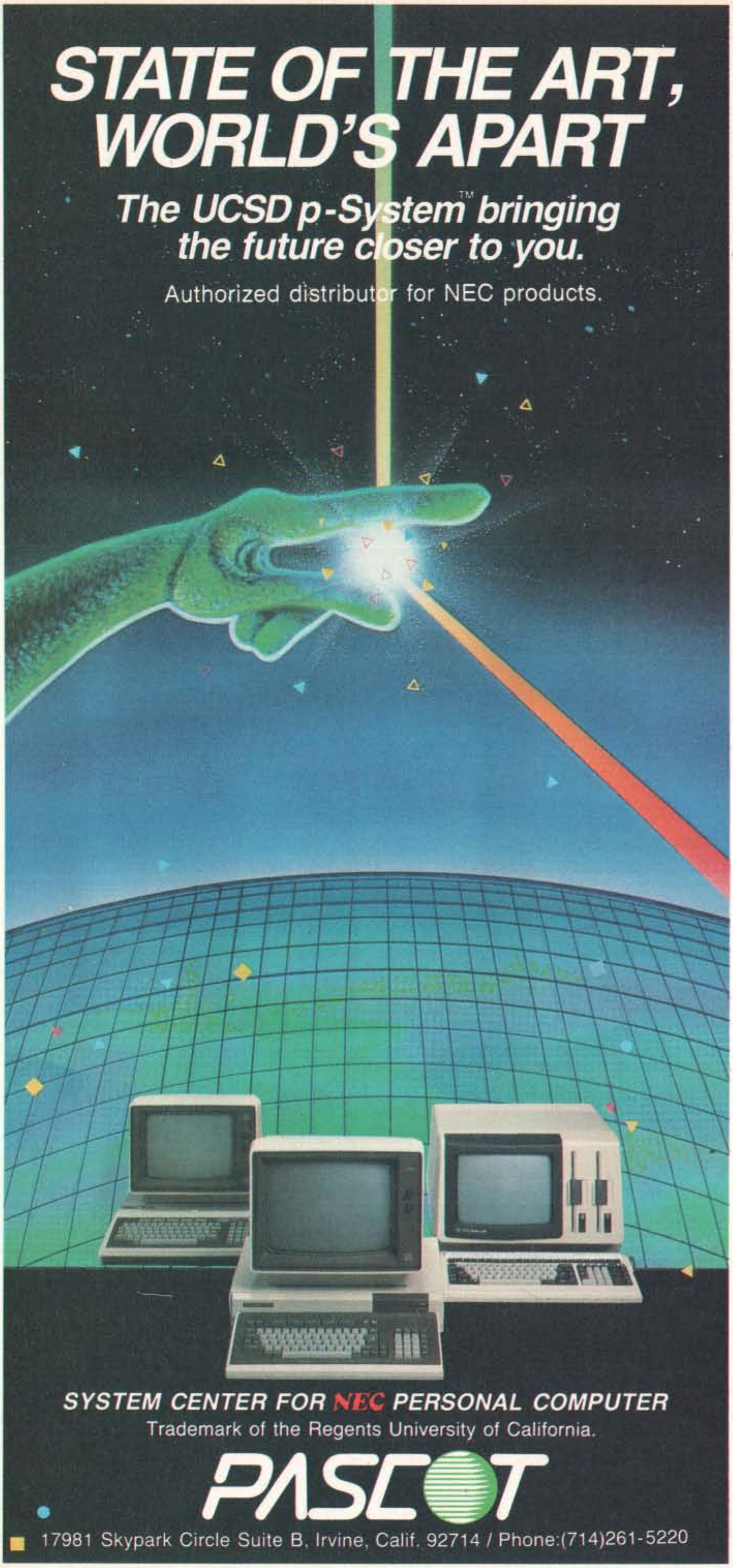
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should do. That, however, was years ago. Evidently the industry has outgrown that kind of relationship with its customers.

Anyway, I didn't tell him that. Instead, I explained that Zenith was in Illinois, while both Tandon and I were in Southern California. "I have a $5000 computer disabled for want of a 10-cent door latch," I said. "And we've got book deadlines, and text we can't access without that machine. We've got some real problems, and I'd really appreciate some help. All I need is a spare part, and I can't find anyone who'll sell it to me."

"We have 2000 employees, we ship 200,000 drives a month, and we can't be bothered with trivia like that. We can't handle spare parts. You don't expect General Motors to do that—"

But of course I *do* expect General Motors to have spare parts. I pointed out that I could go to any one of 50 auto parts stores to buy parts for my car.

"I wonder if that was the case in 1927?"

I allowed that it probably wasn't, although I recall from reading the biographies of Albert Sloan and Henry Ford that both were fanatics about making their dealers stock spare parts.

"I don't think you should be talking to Tandon," he continued. "However, I'll mail you the part."

Once again I breathed a huge sigh of relief, and practically spouted thanks. Then I asked if I could send a messenger for the part, since our need was desperate.

This got me *another* lecture. "We establish guidelines, we establish very definitive procedures, and you're not following them," he said.

I pointed out that if he were going to mail the part, it couldn't be that hard to have whoever would mail it simply take it to the receptionist's desk where we'd pick it up. After another lecture it was allowed that this wouldn't be any worse break in the procedure than sending me the part would be.

I sent Alex out to get it. Since by now I wasn't sure of the reception he'd get, I told him to go also to Priority One and buy a spare drive.

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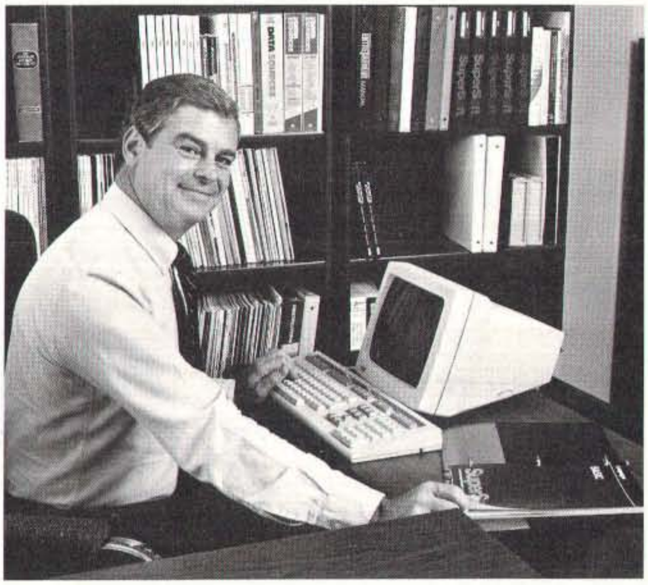

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We could always use it, and that seemed to me good insurance. I wasn't at all sure what the gentleman at Tandon wanted. Product support at Tandon apparently consists of telling users that it doesn't provide any product support.

When Alex arrived, the chap came out to see him, and as Alex put it, he was trying to be polite, but there was this streak in him that insisted that he impress us with just how big a favor he was doing us.

In addition to the door latch, he gave Alex some manuals for the drives. "We usually charge $25 for these," he said. Alex didn't ask who usually paid the $25, since he had made it very clear Tandon didn't deal with end users and didn't want to.

However, we're grateful for the manuals, which do tell us a lot about the care and feeding of Tandon drives. They're not very thick, and I can't think it would cost very much to print them. Surely in quantities of 200,000 they'd be less than a dollar, and they'd sure be useful to anyone owning Tandon disks; they're really quite well done. Oh, well.

I'm not sure what the moral to this story is. I don't want to be unfair to Tandon. I'm trying to fight the conclusion that its attitude is, "We ship 200,000 drives a month. We're Tandon. We don't care. We don't have to." After all, at only the price of a lecture, he did do me the favor I needed, and I had after all asked for something I wasn't entitled to. I really am grateful. (I also bought a spare drive from Priority One, because I don't ever want another iteration of *that*.)

Additions: first, I have a very friendly letter from my first brief contact, saying Tandon does, too, care. I do want to emphasize that the company was very nice to me.

Second, the new drive we bought came without manuals, and is a new model, and as of now Priority One doesn't know how to set the jumpers; but it expects to hear from Tandon Real Soon Now.

Spare Parts

The bottom line of my quest was that Barry Workman and my son Alex have decided to offer Tandon spare parts kits at Workman and Associates. They don't expect to make much money on them. As far as I'm concerned, they're public benefactors, they are, they are. If you own an IBM PC, Zenith Z-100, or any other machine with Tandon 5¼-inch drives, you'd do well to get one of these kits. You may never need it, but if you do, you'll want it *bad*.

Editorial Conversion

Due largely to sloth, we've never converted from Wordmaster as the programming editor used here at Chaos Manor. At one time, Wordmaster was about the best *programming* editor available; however, it hasn't been maintained or supported at Micropro, and it has fallen behind progress. Still I continued to use it from habit, despite having better editors.

But of course I can't use Wordmaster, an 8080 editor, for my Modula-2 programs on the 8088. There were two choices: Superwriter from Sorcim, and Vedit from Com-

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FIRST IN SOFTWARE TECHNOLOGY P.O.Box 1628 Champaign, IL 61820 (217) 359-2112 Telex 270365 puview. Both have lots of nice features. I'm not entirely sure why I chose Vedit, but I did, and that's what we use for programming now.

I'm also changing over on the 8-bit systems, too.

Meanwhile, Compuview is sending me yet another update of Vedit, with its brand-new, completely rewritten documentation; Compuview claims the rewrite was due to my needling, and perhaps it was. Certainly its people have been more than cooperative on the phone.

If you need a programming editor, Vedit's a very good bet.

WRITE Now!

After much needling, wheedling, and plain threats, Tony Pietsch has got WRITE available and ready for publication. All the known bugs are fixed, the documents have been rewritten (from the crash text I did in one marathon session before the 1983 West Coast Computer Faire), and an Install program that knows a dozen printers and twice that many consoles has been done.

WRITE, for those who tuned in late, is the text editor that Larry Niven and I use to write our books. It began some years ago when we requested Tony to fix the bugs in Electric Pencil. That wasn't feasible, and Tony wrote a new editor from scratch. It incorporated the Pencil features we'd liked and added many others.

Over the years Larry and I kept notes of features we wanted and bugs we hated, and Tony produced new versions of WRITE. One of them incorporated the best Search/Replace function (called the macro view editor) I've ever seen. Alas, it was complicated to use, and Ashton-Tate talked Tony into removing it for a much more simpleminded Search/Replace. This was back when it appeared that Ashton-Tate would be the publisher.

The macro view editor isn't in the new release of WRITE, although Tony promises it as an upgrade Real Soon Now. That's a bit sad, because it means I don't have it either; I've always used the latest versions as they came out. The Search/Replace we do have is more than adequate, indeed is as good as that in any *text*-oriented editor I know of; it doesn't approach the power available in Vedit, though.

However, WRITE is quite simply the best text-creation editor I know of. This conclusion is shared by every professional writer who has taken the trouble to learn WRITE. (Naturally I mean all those I know of who've tried WRITE; there may be some who tried it and didn't like it and haven't told me.) In addition to professional writers, a number of beginning writers, such as Dr. Trimpi, who's collaborating on a survival book with me, and Roberta, who just finished her book, are also WRITE enthusiasts. As I've said elsewhere, it's well to get confirmation of one's prejudices.

What we all like about WRITE is its transparency. WRITE doesn't get between you and what you're thinking about. It doesn't natter at you. There are no distracting flickers to give you row and column number each time you press a key (or each time you pause for thought). When you want WRITE to do something, it does it *now*, generally with a single keystroke. It's also very nearly bulletproof. You can lose text with WRITE, but you have to work pretty hard—and even then there's a way to recover it from memory. You have to know a fair amount about CP/M to do that; we've been after Tony to write a Save-It program. The problem is that WRITE so seldom loses text—I can recall every instance over the past five years—and Tony prefers to fix the bug rather than provide the crutch.

It does lack one feature many want: there's no UNDO command. In practice I don't miss it; if you try to delete more than a single line of text, WRITE asks if you really mean it. I have sometimes hit the "Delete To End Of Line" key when I wanted the "Delete Next Word" key (they're right together on my Archive keyboard) and thus lost a line of text, but that's the worst that happens.

The WRITE philosophy is to keep it simple and clean. If you want to get complicated, you can go to a command mode and get complicated; but

Text continued on page 82

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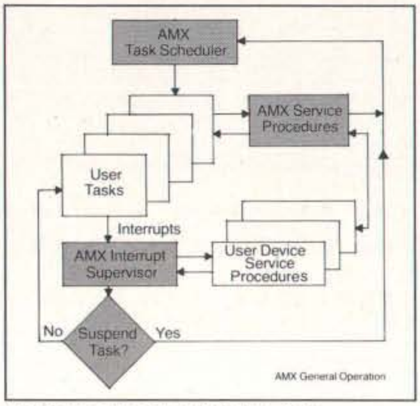

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Text continued from page 78:

while you're writing and editing text, I at least want things to happen fast, with simple commands I can remember, and WRITE has been designed that way.

The bottom line is that I can write 10,000 words, editing as I go; go back and edit again; check spelling (with Wayne Holder's The Word Plus); print the text; and get it out the door in one night. I can't imagine doing that with any other editor.

The text formatting is quite good enough for me, and there's a "print to screen" feature that lets you see precisely what you'll get, including where the paper ends, before you print.

WRITE is no good for mass mailings and computer-generated letters. Peachtext (Magic Wand) is about the best I've seen for that. WRITE isn't useful as a programming editor. It is plenty good enough for letters, now that Tony has added a "letterhead" feature that causes it to skip down to below the letterhead before it begins to print (for first page only unless you tell it different). Larry and I have written movie scripts with WRITE, but there are editors that know the complex indentation scheme scriptwriters use; with WRITE you have to figure out most of that for yourself. I wouldn't recommend WRITE for scriptwriters or programmers; other creative writers may find it the best thing since microcomputers.

WRITE is available for a variety of machines, including Kaypro, Otrona (I expect the keyboard-configuration program I use will be included if you get an Otrona version), Televideo terminals, Lear Siegler terminals, and a whole bunch of others. It knows how to use most standard printers.

WRITE is marketed by Workman and Associates. It will also be available when you purchase new Compupro machines; those with older Compupro equipment will have to buy WRITE from Workman. I obviously recommend it.

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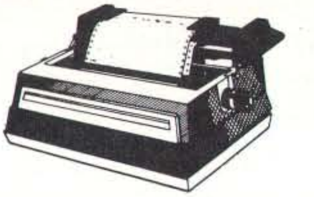

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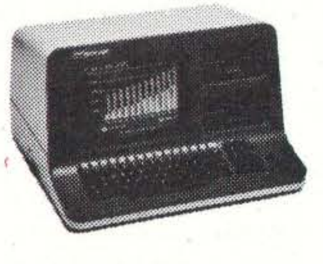

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they cost over $2000 for the pair.

Things sure change. A recent BYTE has a number of ads for two Siemens 8-inch single-sided double-density drives, with power supply and cabinet, for less than $700.

I have no personal experience with these Siemens drives, but Barry Workman used them for Ralph, his Lobo Max-80, and has had no problems after six months of hard use.

I previously mentioned these drives, and we've had a number of letters asking how to configure the drives properly. I asked Barry to write up how he does it. The following is a paraphrase of his reply.

First, the Siemens FDD 100-8 drives have to be configured. Drive A is 0, and drive B is 1. This is done with "U" jumpers on the PC board on the drive. Put the jumper on the selected pin, and be sure it's securely fastened to both pins. These things aren't too strong, and can easily be bent. If you have a wire-wrapping tool, use that. If you get "Select Error," your jumper may not be making proper contact.

Check the PC board carefully. There is another jumper on some of these drives that designates them as hard-sector drives. This will not be on all drives, only some of them. If the selector is hard-wired, it will be hard-wired for soft-sectored disks. If it has the jumper, it will probably be set for hard sector. Make certain the sectoring is what you want. If you don't know what this means, you probably want *soft* sectoring; almost everyone does.

There is a *terminating resistor* on the board. It looks like a blue integrated-circuit chip (the only blue one on the whole board). Remove the terminating resistor from one of the boards; leave it in place on the other. It's usual to leave the resistor in place on drive 1 (B), or the last one in the line if you have more than two.

Now mount the drives in the cabinet and plug in the power cables. Turn on the power. Both drive motors and the cooling fan should come on. If not, check the power-supply fuses, then your connections. *Do not work on any component when the power is on.*

The FDD 100-8 uses a 50-pin edge-card connector. The #1 pin is closest to the slot cut into the connector board. The ribbon cable's #1 pin is closest to the stripe on the cable, if you have a standard cable.

Use the data cable to connect the drives to the computer, and turn on the drives, but *do not* turn on the computer. Take a *blank* disk and insert it into drive A, and close the door. The red LED should *not* go on. Do the same thing with the B drive.

If the red LED on the disk drive is *on*, it means the data cable is connected upside down. This is a lot easier to do than you'd think. Connecting the cable upside down can be fatal to disks if the computer is trying to read.

Now that you have the cable connected properly, turn on the computer, insert the system disk, and make a copy of your system master.

Troubles

Barry Workman goes on to say, "If you have been running for some time, and you begin to get bad sector error messages, open up the cabinet and see if the stepper motor is catching on anything. I had one drive that started to do this with greater regularity than Ex-Lax. What was happening was that the stop was hanging the head at about track 1 or 2, and the computer was trying to find track 0 information there.

"If the drives are still under warranty, don't muck with them, take 'em back. If you have to work on them yourself, look for burrs on the worm gear. Also look to see if the lubricant has got sticky.

"The FDD 100-8s are sound drives, and I'm not afraid to recommend them to anyone trying to get a system running at low cost. Because of their low cost, don't buy two drives, buy three. If you have problems with one, you can swap out while you have repairs made. Anyone who can repair Shugart drives ought to be able to work on Siemens."

Barry has put together a two-page tattle sheet about Siemens drives, including tips on maintenance. He also includes a diagram showing the location of the critical jumpers. This is available for $1, and he'd appreciate a stamped, self-addressed envelope since it costs more than a dollar in employee time to put these out. The above was cribbed from his tip sheet.

And Again the Epson

After my evaluation of the Epson QX-10 with Rising Star's Valdocs software appeared in the August BYTE, I received a letter from Steve Irving, Software Development Manager for Epson America. After some conversation, he sent out the standard Epson keyboard and CP/M software package.

That works a lot better, but, alas, my beta-test QX-10 had trouble with the B: drive. It seems to be an intermittent hardware problem. Diagnosis was complicated by CP+, which Epson puts onto the standard CP/M master it furnishes. When you boot up, you get CP+ whether you like it or not.

CP+ is a shell around CP/M. It's supposed to protect you from the horrors of having to learn PIP A:=B: and the like. Steve Irving says it's intended to allow naive users to have an instantly rewarding experience; they can turn on the machine and do something useful. To quote Steve, "Whatever phobia can be ascribed to turning on your first computer and staring "A>" in the face, I experienced several years ago. Consequently I wanted to find a way for Epson's first-time users to avoid this shock."

CP+ is menu-driven, and certainly is easier to use than CP/M if you've never had much to do with computers, but it's really slow, about as slow as Valdocs. In fact, CP+ is guaranteed to drive experienced CP/M users crazy. It's especially troubling when you first get it, because it must be "unlocked" through a fairly complicated series of moves I wasn't prepared to make. This is to prevent users from accidentally erasing or altering files. It also prevented me from copying the system disk.

Given the intermittent hardware problem, I almost went nuts trying to make a copy of the master disk. PIP * . *[r] ([r] causes PIP to copy "hidden" system files as well as visible directory files) worked just fine, but Epson hadn't provided SYSGEN, so

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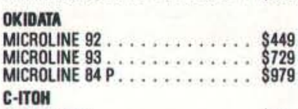

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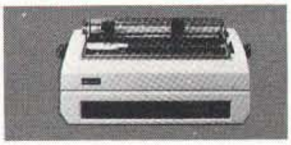

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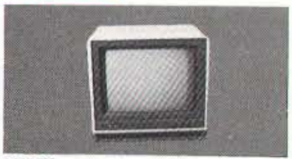

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Circle 198 on inquiry card.

I couldn't make a new master that way. (It turns out SYSGEN is buried in the Epson Copydisk utility program.)

You can, with work, get past CP+ to regular CP/M. I'm also told that in the "demo" or "locked" mode "the new user is led through a complete tutorial of CP+, which includes a rather painless introduction to the operating system." After that CP+ is unlocked.

I haven't tried that yet, because I don't have *Using CP/M-80 with the QX-10*. This is normally supplied, but somehow got left out of the package sent to me. Once I have that, and stable hardware, I'll have John Carr try the CP+ tutorial.

Irving says, "I hope you will agree that among the options of requiring the novice user to install the auto boot feature to get to CP+ or requiring the experienced user to disable it, the latter is preferred."

I do agree with that; but I'd like it even better if Epson included an *additional* disk, plainly marked "Standard CP/M; not for the novice user." That disk could have standard COPY, and PIP, and SYSGEN, and MOVCPM and DDT and ED and STAT and all the other stuff CP/M users have come to expect. It could also have the source code to the Epson BIOS (basic input/output system). It wouldn't cost much to provide, and it sure would make it easier for people who know CP/M.

I think Epson got so involved with making the QX-10 user-friendly to inexperienced people that it compromised the machine's ultimate usefulness. This is a pity, because it's such a nice machine. There are some excellent features to Epson CP/M. The operating system catches many BDOS (basic disk operating system) errors and deals with them. For example, my hardware problem manifests itself with a "Select Error," meaning that the hardware sometimes signals that the disk-drive door isn't closed when in fact it is. Epson sends the message "Drive Not Ready," and gives the opportunity to retry. A couple of retries fixes the problem. This sure beats heck out of some systems that can't recover from any error. (Epson is taking care of my hardware problem, too. I had a *very* early beta-test machine; it's swapping for a later production model.)

In any event, the little machine is as fast as any 5¼-inch-drive machine I've seen. It also has a type-ahead buffer; if you get angry and hit Control-C 10 times, be prepared to see it execute 10 warm boots! This is a feature that takes getting used to. (It can also be disabled.)

Some impressions: first, the Epson standard keyboard isn't laid out the way I like keyboards. The ":" is lowercase, quotation marks are capital numbers, and in fact it's a Teletype keyboard. This seems odd, since the people who like this as opposed to a Selectric layout tend to be hackers—but the QX-10 is most assuredly not intended for hackers, else Epson would hardly have put the CP+ shell around CP/M!

The QX-10 has a completely reconfigurable keyboard, though, and I suppose the key tops are standard so that you could, with some effort, set

Text continued on page 91

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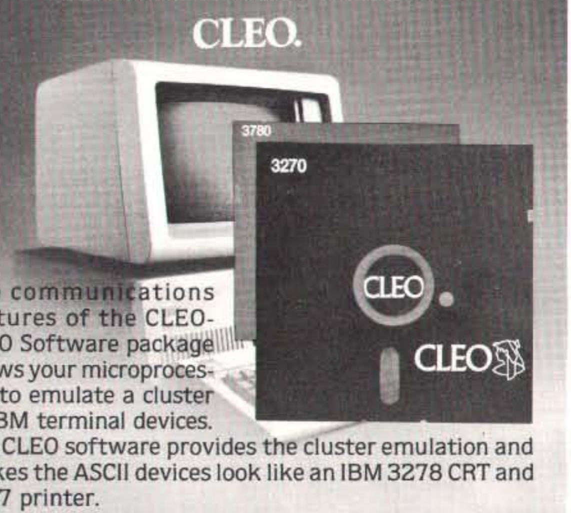

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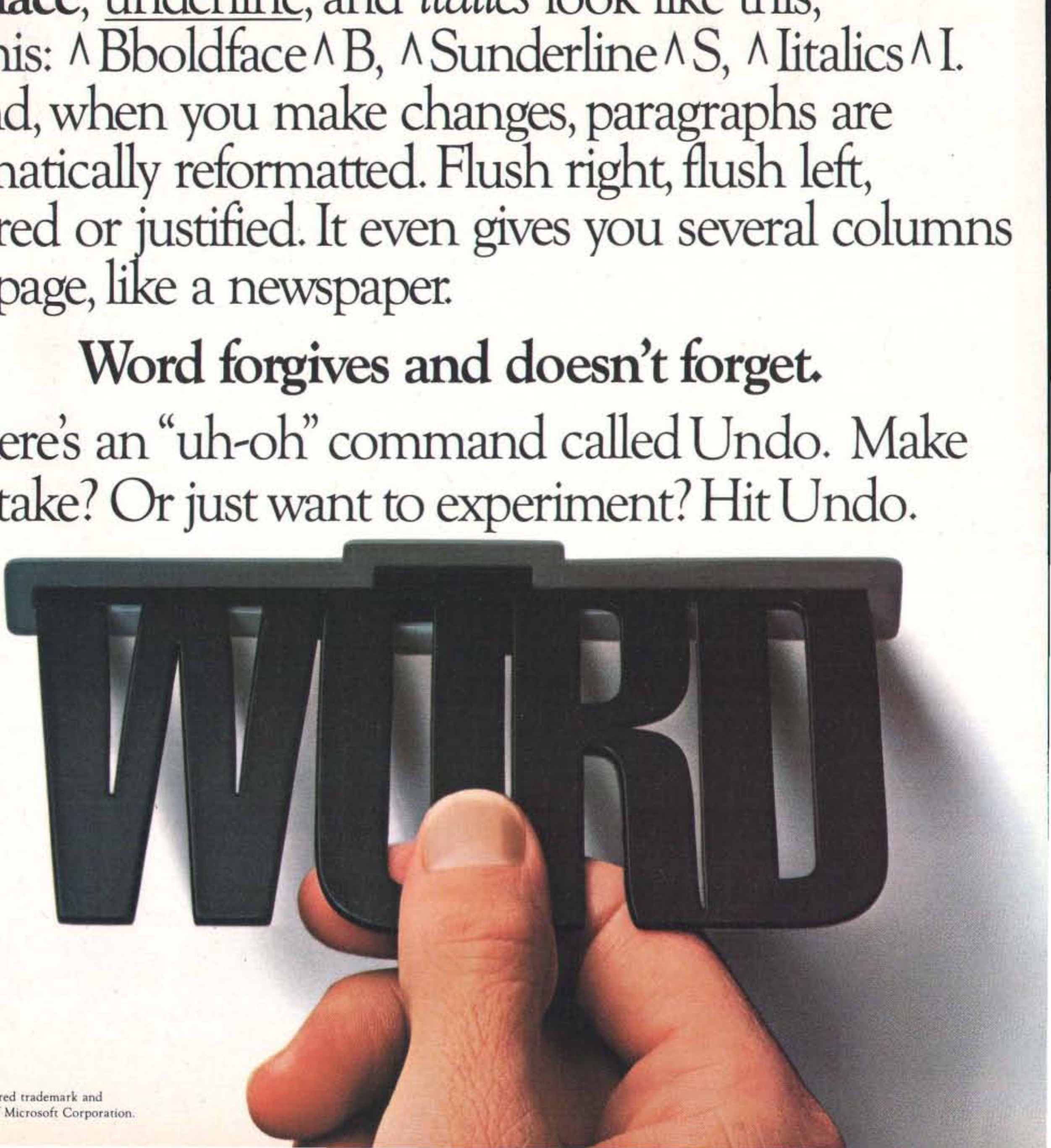
There's an "uh-oh" command called Undo. Make a mistake? Or just want to experiment? Hit Undo.



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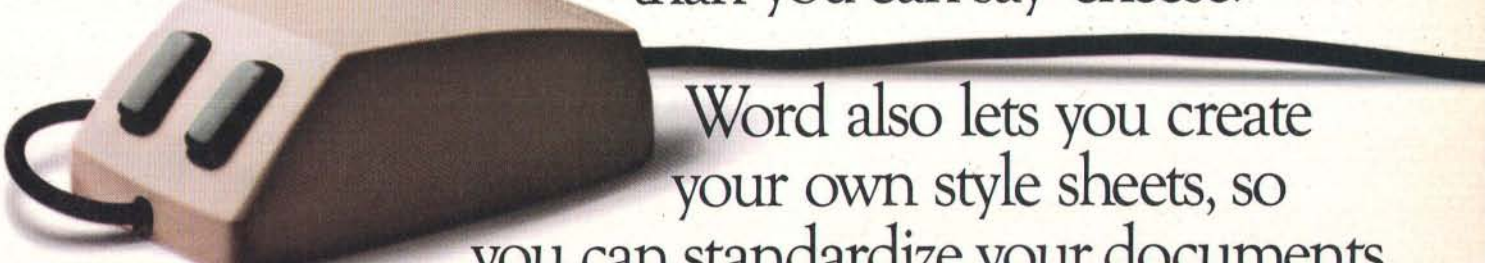

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Text continued from page 86:

the keyboard up the way you'd like it. It might even be worth the trouble. The Epson is really a nice little machine, and with that wonderful memory-mapped video screen you can get really great graphics, halftones, and such like. I really like the Epson's display and character set, and it's all very readable (if you like a green screen). Incidentally, the standard CP/M (without Valdocs) Epson emulates a Televideo 920 terminal. However, the company intends in the future to have an Epson QX-10 terminal type, "which will take full advantage of all the available keys and display attributes."

Meanwhile, all the applications software I've seen for the Epson tends to be Peachtree, and therein lies a problem. The Peachtext editor I have presumes that you're going to use the HASCI keyboard that usually comes with the Valdocs option; there's even a little paper template you can put over the HASCI function keys to show what their functions are in Peachtext.

HASCI is the name Rising Star's Chris Rutkowski has given to his special-design keyboard. The HASCI keyboard looks a lot like a Selectric, and it's really well designed, but it lacks some significant keys. No Escape key, for example. Also, the Control key is set down below the space bar; good enough for word processing since the Valdocs software intended to be used with the HASCI keyboard seldom uses control characters, but horrible if you intend to do any programming on your Epson QX-10.

Peachtext, incidentally, is the word processor once known as Magic Wand. It's a perfectly adequate text editor, although for reasons I've given in other columns it will never be my favorite.

While in Peachtext you can type as fast as you like, and you won't get ahead of the computer's ability to put the letters you typed onto the screen. Under Valdocs you can get from a couple of words to a whole sentence ahead of the screen display! This conclusively proves that the delay is in the Valdocs software, not in the QX-10 hardware.

My impression of the QX-10 is that it's a fine little machine. It would be a lot more useful, though, if instead of being so concerned for user friendliness when you first get it, Epson would worry more about utility after you've got it. A disk with standard CP/M would help. Adding a few general utilities, like a sorted directory with file sizes and the like, would help even more. (Barry Workman has already put his various utilities into Epson disk format, so these features are available if you want them.)

Agreed, there's a lot to be said for a shell around CP/M to help people get past the first few days. You pay a pretty hefty price in operation speed, but perhaps it's worth it—at first. However, most users will soon prefer to learn how to do things faster; there's nothing more boring than sitting at a computer whose screen say "Please Wait" for half a minute.

Meanwhile: I've just received a new revision of the Valdocs software. Rising Star swears it fixes most of the

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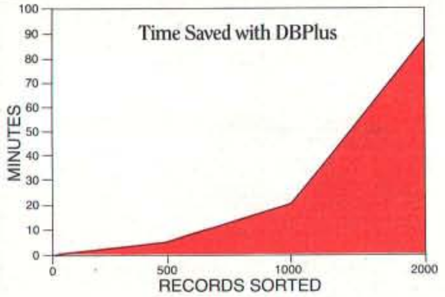

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Circle 218 on inquiry card.

bugs, and speeds things up something wonderful. I'll try it as soon as I'm sure the hardware is working.

I also got a new, and excellent, manual for the FX-81 printer.

My bottom-line advice on the Epson is that if you're planning on getting a computer in its price range, do look at the Epson. You might like it a lot.

However, insist on a thorough demonstration. Make them copy disks, copy files, format stuff, run the text editor, and in general do all the things you're buying a computer for. Then look at something else, and see how long it takes. It's awful easy to say you'd rather have ease of use than speed, but most people find they're not willing to make that trade forever.

Kazango!

Everyone is coming up with powerful new machines. Bill Godbout has prototype S-100 computers based on the iAPX286 chip, 68000-based systems multiply, and everywhere you look the speed and capability of microcomputers soar almost without limit. I'm getting afraid to make predictions: sometimes things I predict for two years hence happen before my words get into print!

Example: this afternoon I had a call from Richard Mateosian, author of the excellent Sybex book *Inside Basic Games* (reviewed in the April 1983 column). Mateosian has access to an experimental microcomputer based on the 16032 chip. He reports using my matrix filler and multiplier benchmark: for the 20 by 20 case the time was well under a second, so fast that it's not really possible to measure it. I asked him to try the 100 by 100 and time that. Meanwhile, that's *fast*.

Shirley and Some Prognostications

I've known for more than a year about Bill Godbout's new multiuser all-in-one computer. It had a code name of "Shirley," and Compupro is having trouble finding a real name for it; all the ones come up with so far sound hokey. Doubtless it will end up being something official and stuffy, and I'll prefer Shirley.

Flash: the announcement is out;

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Shirley is officially named the MP-10. I see no reason to change the above paragraph. . . .

Anyway, we've now seen the prototype. Shirley will be in a metal box. Dr. Godbout prefers metal; it cuts down on extraneous electrical noise in the system. It's intended as a four-user system, and will have both hard and floppy disks, and will be the first all-up machine Compupro has put out; up to now it has stayed exclusively with the S-100 bus.

The Shirley operating system will be MP/M; when reporters asked Godbout about PC-DOS, he sort of chuckled, which is reasonable. There are persistent rumors that Digital Research will soon come out with a multiuser version of Concurrent CP/M that runs PC-DOS programs directly (not as an emulation). I suspect Shirley will have that feature.

Dr. Godbout sees a few more years for the S-100 bus. The iAPX286 and 16032 machines will work with it. The 8086 with the 8087 math chip will challenge the 68000, and they can be upgraded to the iAPX286. The 16032 with its highly advanced architecture waits like a dark horse in the wings.

The problem with the 68000, according to Bill Godbout, is that there's no clear upward migration for it. Of course 68000 enthusiasts—my son is one of them—say there's no *need* for upward migration for the 68000.

In any event, S-100-bus machines that are truly IEEE-696 standard will give the user a lot of flexibility, since you can convert from Z80 to 8088 to 8086/8087 to iAPX286, and then change the whole farshimelt mess to a 68000 if that's what's needed. Of course, eventually technology is going to run past all buses, because the distances between the slots in the box are just too long; but that won't happen for a while. Meanwhile, you find Compupro S-100 machines in the strangest places: all the special computer displays in the model "War Room" for the movie *WarGames* were controlled by a Compupro, as an example.

When Bill Godbout called me yesterday, he had a complaint: it certainly used to be true that Compupro

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Star Trek		postpaid	$19.50
WRITE		in U.S.	$239
Epson QX-10	Epson America 3415 Kashiwa St. Torrance, CA 90505 (213) 539-9140	with 64K-byte RAM	$2495
		with 128K-byte RAM	$2995
General Computer Supplies	California Digital POB 3097B Torrance, CA 90503 (800) 421-5041		
Megabyte Memory Board	Macrotech International Corporation 20630 Lassen St. Chatsworth, CA 91311 (213) 700-1501		$2449
Modula-2	Logitech 165 University Ave. Palo Alto, CA 94301 (415) 326-3885		$495
Modula-2	Volition Systems POB 1236 Del Mar, CA 92014 (619) 481-2286	Apple	$495
		IBM and Sage	$595
Vedit	Compuview Products Inc. 1955 Pauline Blvd., Suite 200 Ann Arbor, MI 48103 (313) 996-1299		$150
Zenith Z-100 Computer	Zenith Data Systems 1000 Milwaukee Ave. Glenview, IL 60025 (312) 391-8865		$2899

machines were largely intended for hackers and system developers, and the company doesn't intend to let go of its dominance in that end of the micro field; but largely due to my needling him, both privately and in the column, about its lack of support for naive users, Compupro went out and hired the Xerox field service organization to provide servicing agreements for Compupro equipment; every one of the Compupro Systems Centers was required to send at least one key employee through an intensive sales training course designed to show what's wrong with the customer service in the computer industry, and how to correct it; and Compupro has been doing more intensive training of its systems service people. Finally, it rewrote many of its documents.

"So I did everything you wanted. When are you going to admit it?"

I'll reserve my opinion on just how far he had his tongue rammed up his cheek when he told me of my vast influence, but in fairness I do have to report that it's all true. I wish all the computer manufacturers would insist that their salespeople know something about the product—including its limitations.

Time Waster

A few issues ago I mentioned I'd written the world's most complex Star Trek game. I may have exaggerated. In any event, we've had several inquiries about the game, so I've turned it over to Barry Workman. It's probably overpriced, but the realities of the software mail-order business prevent him from shipping disks postpaid for less.

My Trek game is written in CB-80 and runs really fast. I've stuck in all kinds of silly features, including exploration, enemy bases, enemy attacks on Federation merchant ships, enemy attacks on your star bases, Tholian Webs, Romulan invisibility, and such like. My kids like it, and I confess that I've wasted a bit of time with it myself. I'm too ashamed to recommend it; I'll merely say it's available.

By next time I surely will have my IBM PC. I hope to have a report on the PC vs. the Eagle, and also to reduce that stack of unreviewed PC software.

However, I know better than to make promises. . . . ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.

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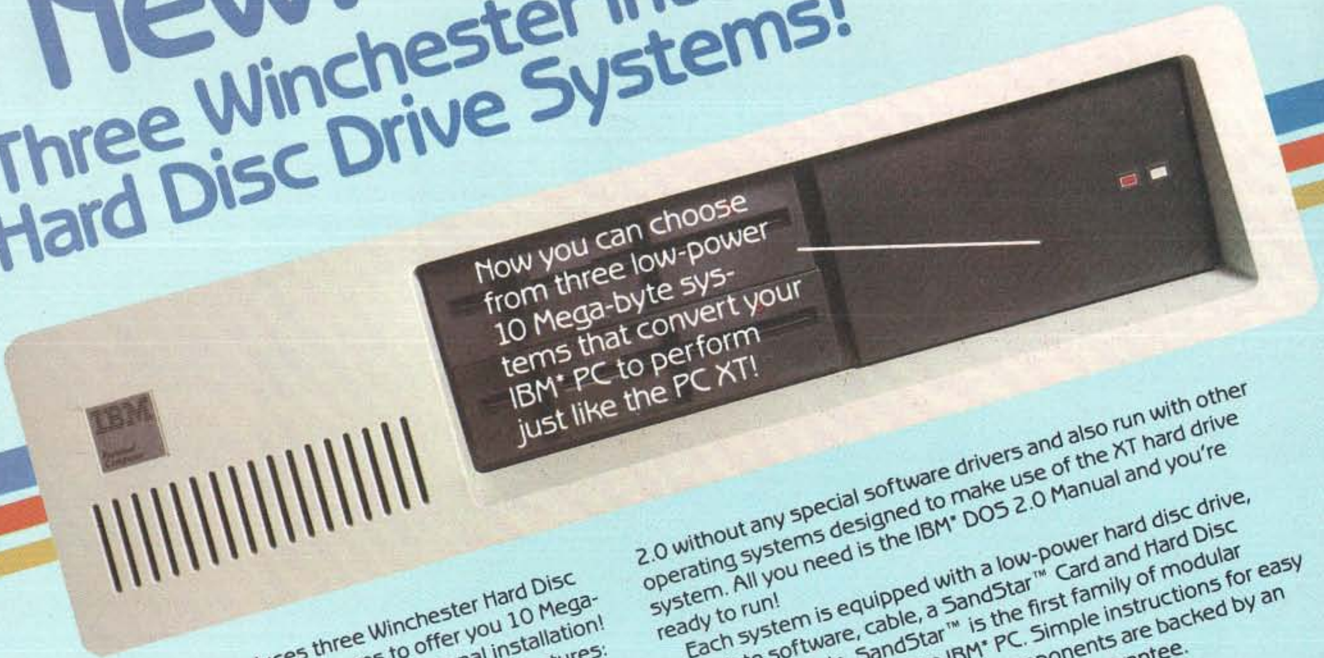
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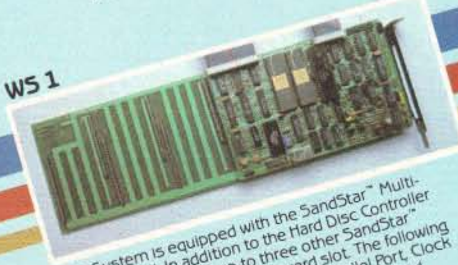
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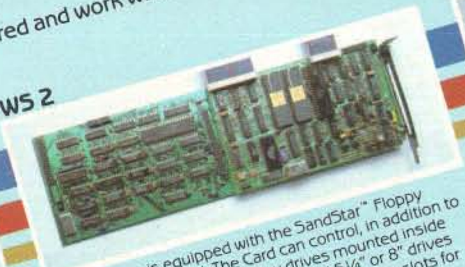
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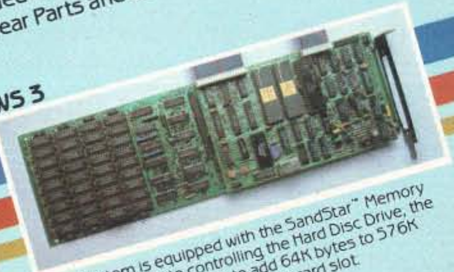
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High Speed Programable Ranges	Yes	No	No	Yes	No
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Data Acquisition BASIC	Yes	Yes	Yes	Yes	No
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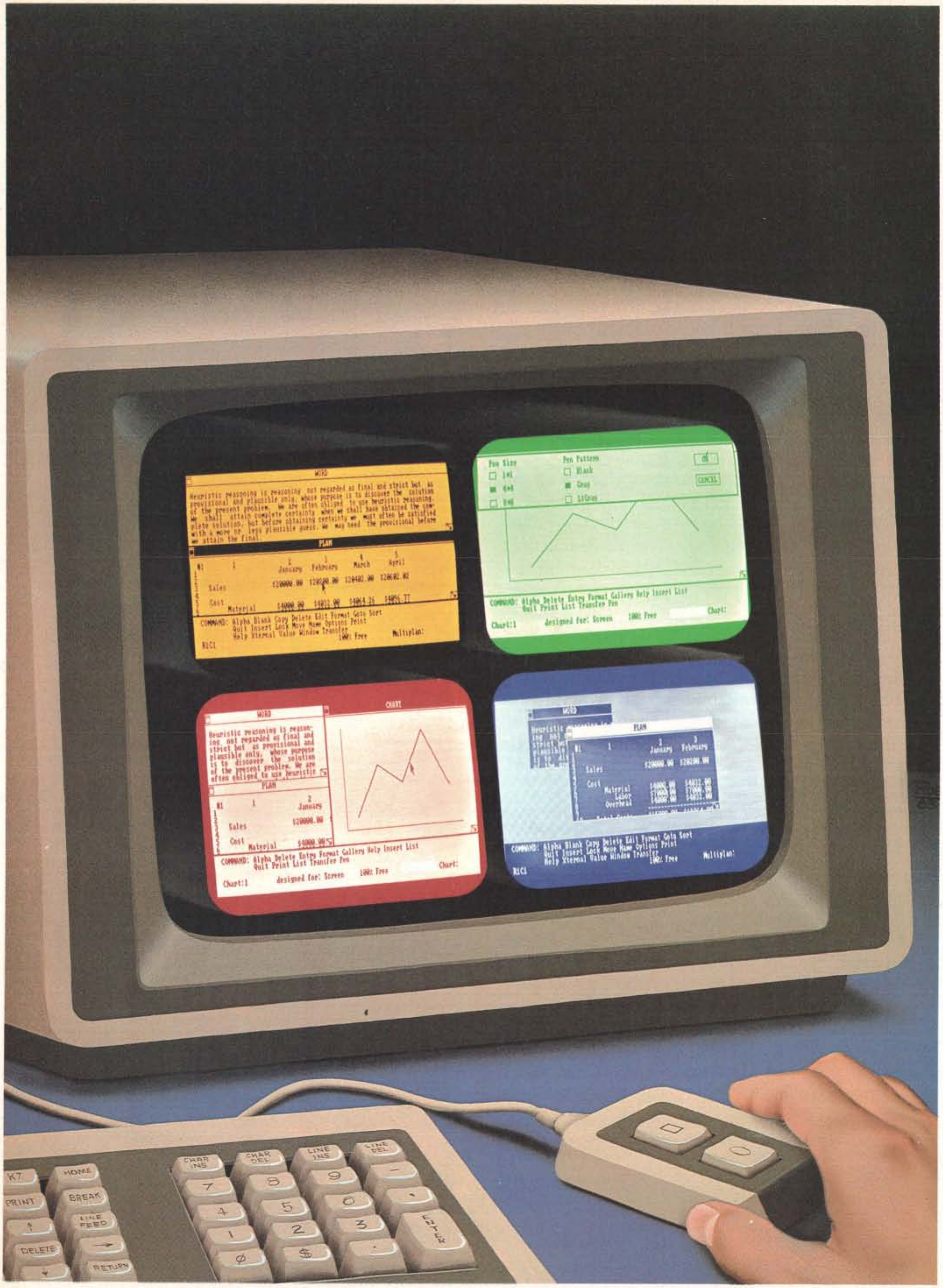
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Easy Software

It isn't easy to make software that's easy for people to use. People think intuitively and symbolically, but computers don't think at all—they just manipulate voltage levels that people can most accurately represent as wave forms or strings of ones and zeros. Creative programmers and engineers are trying different ways of translating long strings of ones and zeros into symbols, expressions, and structures that people can manipulate easily.

This month BYTE offers a sampling of the efforts that programmers are undertaking to make software easy. Integration of software comes under discussion as well because it is inseparable from ease of use; giving separate programs a common user interface is a major step toward integrating them.

The theme articles in this issue provide several different views of what is now the most praised approach to user interface technology—the desktop metaphor that lets users choose actions by pointing at pictorial symbols on an imaginary desktop. In addition to an introduction to desktop-metaphor software, we compare different kinds of pointing devices, discuss the concept of metaphor in software, look at the future of metaphors, and preview Microsoft Windows, a new desktop-metaphor system that seems to be the first one capable of running without a hard disk and a lot of memory.

An implicitly skeptical view of the desktop metaphor emerges in Tom Houston's suggestions of new metaphors that appeal to human instincts far deeper than those associated with desks, file folders, and wastebaskets.

But the desktop metaphor is not the only approach to the user interface that this issue addresses. Jack Carroll of IBM takes a broader look at the evolution of the user interface in software. Bob Nicholson of Sydis considers the role of voice in the user interface. Sam Edwards of Software Publishing, publisher of PFS: File and other programs often praised for ease of use, reveals some of the thought behind them. Martin Dean of Select Information Systems looks beyond the easy-to-learn Select word processor to other issues in the user interface, including aspects that relate to databases.

Different disciplines often borrow important ideas from one another. Paul Heckel of Quickview Systems ventures into the world of Walt Disney cartoons to bring back some lessons for applications programmers. Steve Vandor of Micropro explains an approach to the user interface that is based on the concept of division of labor, as old as the industrial revolution.

Martin Herbach of Sorcim, Richard Katz of Osborne/McGraw-Hill, and Joe Landau of Applied Software Technology join in a forum on the user interface that ranges from the role of hardware advances to on-screen help information and the structuring of software in layers that hide everything from the users except what they need. Michael Brown of Innovative Software argues persuasively that the foundation of integrated software should be a database.

Programming languages, too, need improvements in the user interface, and Andy Pope, Dan Fineberg, and Geoff Kates of Microfocus describe one way of making debugging a more visual process.

Perhaps the best assessment of the state of user-interface technology today comes from Apple's Bill Atkinson, author of the unrivaled Quickdraw graphics software that runs on Lisa. "What we know about the user interface today," he says, "is 10 percent of what we will know in 1990." This issue lets you examine some portion of that 10 percent and invites you to speculate about the 90 percent still to be learned. —Phil Lemmons

103 **An Introduction to Integrated Software** by Dash Chang

113 **Presentation and Form in User-Interface Architecture** by John M. Carroll

127 **Why Is Software So Hard to Use?** by Sam Edwards

143 **Walt Disney and User-Oriented Software** by Paul Heckel

155 **Making Life Easier for Professional and Novice Programmers** by Andy Pope, Geoff Kates, and Dan Fineberg

161 **Simplify, Simplify, Simplify** by Martin Dean

177 **Integrating Voice in the Office World** by Robert T. Nicholson

189 **The Starburst User Interface** by Steven Vandor

199 **The Complete Information-Management System** by Michael J. Brown

210 **The Allegory of Software** by Tom Houston

218 **The New Interface Technology** by Robert W. Warfield and George M. White

234 **Trackball-Interfacing Techniques for Microprocessors** by Edward W. Andrews

247 **The User Interface: Two Approaches** by Martin Herbach, Richard Katz, and Joseph Landau

263 **The Future of Metaphor in Man-Computer Systems** by Chuck Clanton

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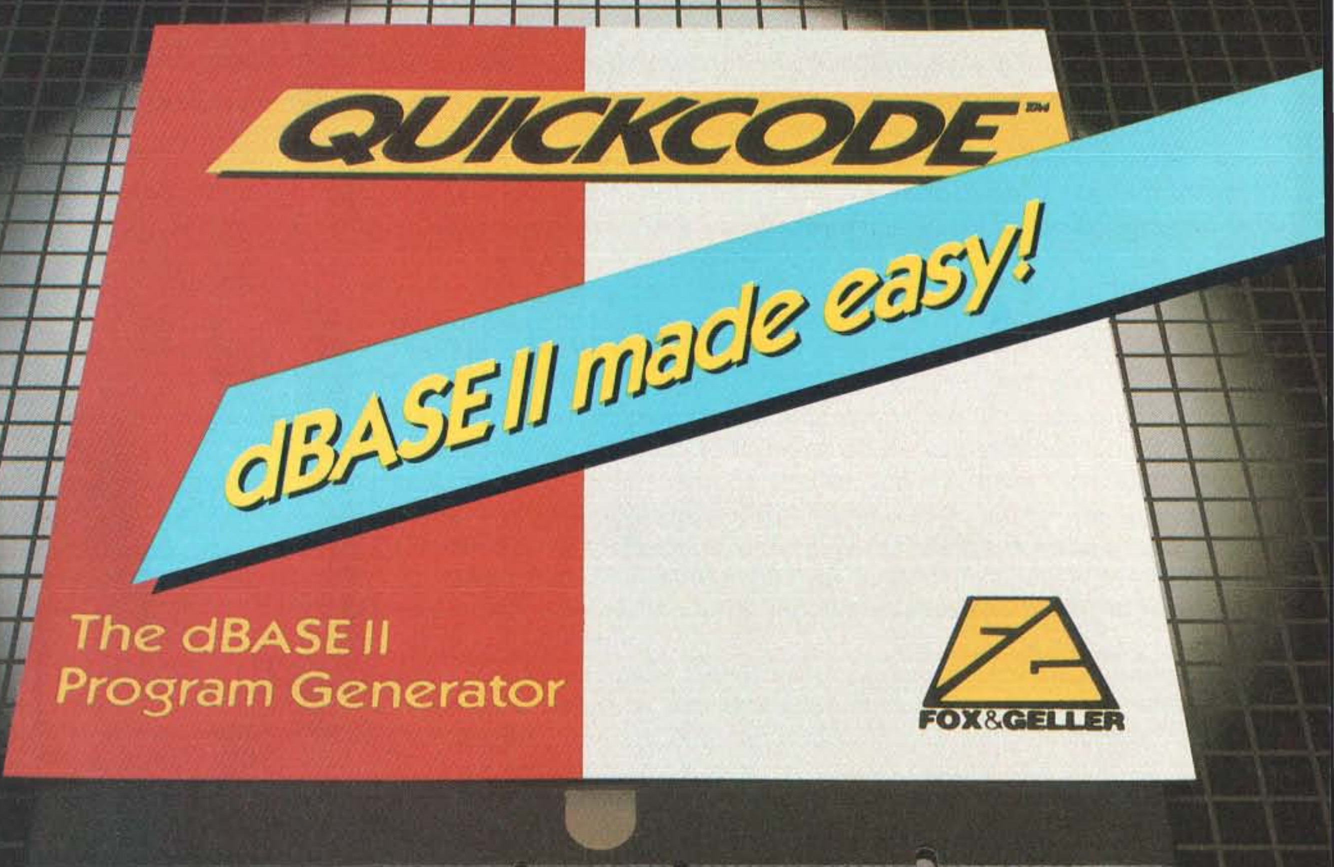

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An Introduction to Integrated Software

Concurrency, shared technology, and functional integration are three ways of integrating software

by Dash Chang

You may remember 1983 as the year of integrated software for microcomputers. We saw announcements of the Lisa workstation from Apple, 1-2-3 from Lotus, Visi On from Visicorp, and Concurrent CP/M from Digital Research. While the microcomputer audience experiences some confusion over what it all means, the promise of these new products is nothing short of exciting.

Before "integrated" becomes as overused a label as "user-friendly," we should define our terms. Integrated software means software that has a high level of functionality and is easy to use. Simply, integrated software lets you accomplish complicated tasks over a short period of time with a minimum of interaction with the computer.

Many computer users pose tasks that defy easy computerization. The following wish list is a case in point. "I want to store all my inventory on the computer so that I can look at my stocking items on request. In addition, it would be useful if I could experiment with the data and see the bottom-line effect if I change my stocking policy. I'd also like to see the results graphically. If I had all of my data on the computer, I could also produce computerized quotations. . . ."

Software integration promises a method of making dreams such as these come true with a minimum of effort.

Software Technologies

Over the past few years, some software packages have emerged that enable customers to solve complex problems with relative ease. Visicalc, Visicorp's electronic spreadsheet, started the revolution; with it, you can ask "what if" questions and calculate the results. Wordstar, a word processor from Micropro Corporation, works with computers to help generate letters and lengthy documents.

Integrated software is only the next step toward making microcomputers more useful.

Since then, new packages like Chang Laboratories' Microplan, Microsoft's Multiplan, and Visicorp's Advanced Visicalc make those originals appear rudimentary. Expanded functions let you solve more complicated problems with less effort, in both initial learning and continued use. As new packages offer more enhancements, the number of problems that you can successfully tackle increases. Yet a total integrated solution continues to evade software designers. Word processors, financial-planning spreadsheets, data managers, and graphics packages will represent single solutions to specific problems.

Integration

Software developers propose to integrate databases with worksheets, graphics, and word processing, producing a single set of products that addresses a larger set of user needs. Integrated software is the next step toward making microcomputers more useful.

Similar product names, such as the Lisa (Apple Computer Inc.), Visi (Visicorp), Plan (Chang Laboratories), and Super (Sorcim Corporation) families are only the beginning. While a complete family of products is a necessary step toward integration, it doesn't result in the total package that software developers are aiming at.

Another approach focuses on the command interface. Products in this category require similar keystrokes in response to similar display screens. Again, this is an important part of integrated software, but it is still far from a complete implementation.

Generally, you can classify current integration technology as including one or all of the following: concurrency, shared technology, and functional integration.

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Concurrency

Concurrency lets different products reside in the computer's memory at the same time. You can load word-processor and spreadsheet programs into memory and switch instantaneously from one to the other with a single keystroke. This spares you the time-consuming process of saving the results from one product, leaving the package, starting up another package, and continuing with the next step in the problem. (Although, technically, concurrency provides more benefits than just concurrent residence of programs in memory, for now I'll discuss only the memory aspect of concurrency.)

Lisa's Desktop Manager provides one example of concurrency. The programs that handle documents and worksheets are automatically loaded in memory. When you need one of the programs, you use a mouse to move the screen cursor to the program's symbol, and the software is instantly available for use. Visi On and Concurrent CP/M provide similar options but differ from the Lisa software in that they can be implemented on different computers. This makes it possible for you to enhance the capabilities of a computer you already own.

[Editor's note: *Depending on the amount of memory available, the Lisa computer may have some or all of every current task in memory. All Lisa programs are segmented so that portions can be stored to disk or called into memory as needed. A similar situation exists with Visi On, which always has some code in memory that relates to each task. Given the above amplifications, we can say that both Lisa and Visi On software are concurrent. . . .* **G. W.]**

Concurrency means that different products reside in the computer's memory at the same time.

Another important distinction is that these products are not application programs but enhancements to the computer's operating system; they manage the hardware and provide a more friendly and responsive computer environment for users. In some ways, you can view these programs as part of the computer rather than applications that address specific user problems. As application programs begin to fully use the capabilities of concurrent operating systems, you will find integrated packages that are even easier to use than existing products.

Shared Technology

The second class of integrated solutions includes the shared-technology products. A single such product handles not only numbers but words and pictures, all at the same time.

For example, Graphplan from Chang Laboratories, 1-2-3 from Lotus, and MBA from Context all combine traditional spreadsheet technology with graphics capabilities and some database features such as sorting and searching. These products let you take a set of numbers and produce

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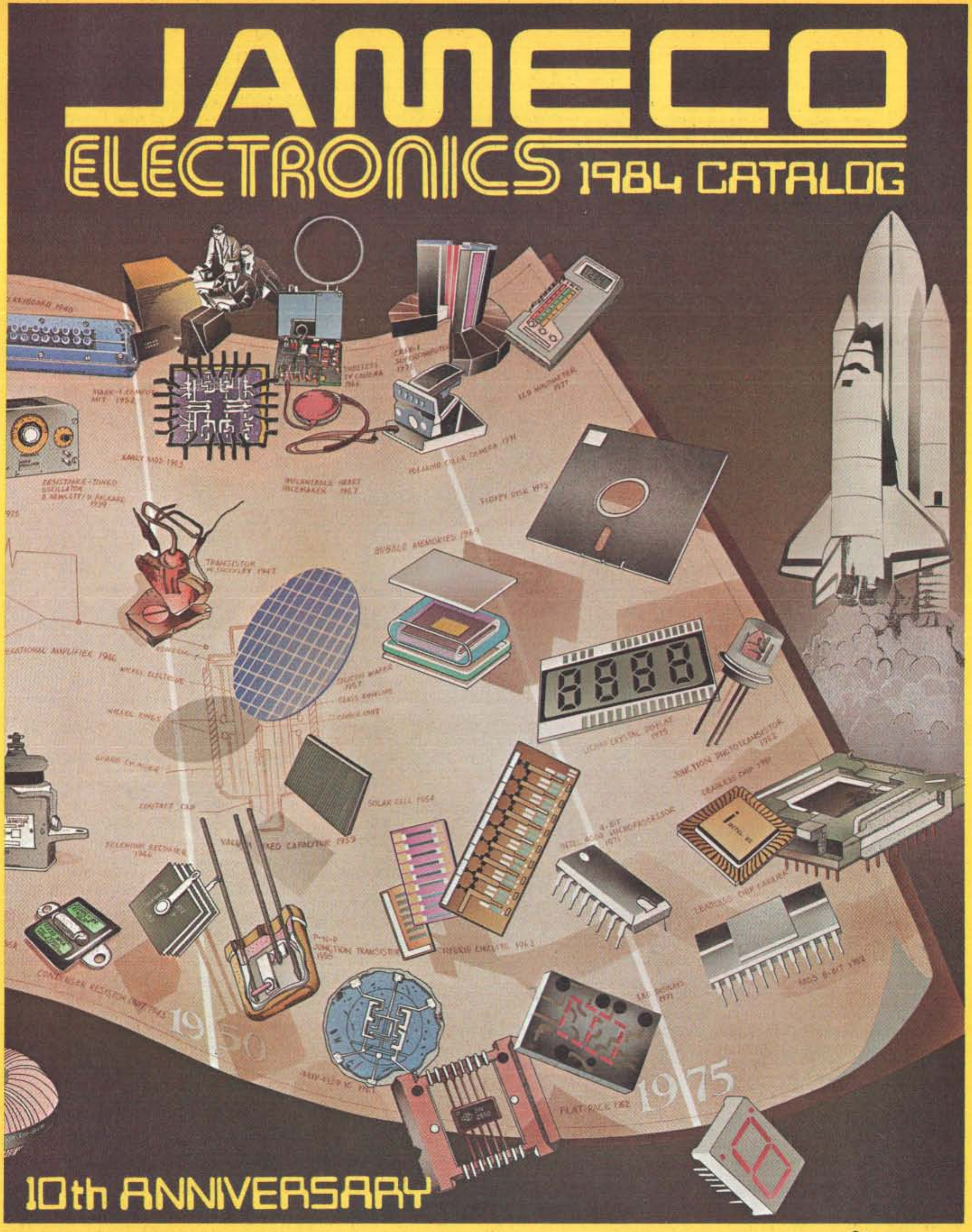

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graphic results as well as printed tables.

The shared technology concept isn't new. For example, most dedicated word-processing computers have always had the ability to handle mathematics, very much like an electronic worksheet.

Expect more shared technology products for microcomputers. Just as combining mechanical and electronic engineering produces breakthroughs in robotics, combining technologies in the processing of words, numbers, voice, and graphics promises innovative software products.

Functional Integration

Finally, the third type of integration provides functional results; the results of one product can be fed to another product for further manipulation.

Examples include spelling checkers, form-letter generators, and integrated accounting packages. The purpose of a spelling checker is obvious. In form-letter generation, you might generate a mailing list using a data-management package, then create a skeleton letter using a word processor, and, finally, produce a stack of custom letters using a product that merges the two parts.

Shared technology means that a single product handles not only numbers but words and pictures, all at the same time.

In integrated accounting packages, the orders module may change your inventory and accounts-receivable files. Then the accounts-receivable and accounts-payable packages will automatically create entries for the general ledger.

Functional integration offers the greatest challenge for application designers—not only to provide a generalized interaction between database management and electronic-worksheet technology, but also to handle the interface between the world of

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data on mainframes and microcomputer application programs.

Although developers suggest that shared-technology products will make functionally integrated standalone products obsolete, this result is unlikely. The range of problems needing computerization exceeds the capabilities of any one system or package. For example, you wouldn't use 1-2-3 to write a book, MBA to store your inventory records, or either one to produce an integrated slide show.

Choosing Hardware

Given the amount of integrated software under development, how should you choose hardware to take advantage of its features? First, you must determine your requirements. Not every problem nor every computer user needs integrated software. If your problems do require a complex solution, then prepare to purchase a more expensive system because integrated software generally requires more computer memory, which quickly translates into more dollars. For example, Lisa supplies 1 megabyte of memory storage, while Visi On and Concurrent CP/M can use up to 512K bytes of data. Therefore, you should consider 16-bit computers like the IBM PC, the DEC Rainbow, the TI Professional, or the Victor 9000. Eight-bit computers like the Apple II and the Osborne 1 simply don't have the memory capacity to handle the new integrated software products.

Graphics are an important consideration, too, because they display symbols that make the computer easier to use. Graphics also let you use different character fonts that make presentations more attractive and bar and pie charts that give new meaning to a collection of data.

If your system supports graphics, you need a printer or a plotter that can print the symbols displayed on your screen. Most printers offer graphics support as an added option, and many include it as standard.

Finally, a pointing device like a mouse may be useful. Some computers let you execute commands by pointing to the items on the display with your finger (touchscreen) or a light pen. All these pointing devices are similar in that they attempt to make the software easier to use.

Plans for an Integrated Product Line

Chang Laboratories has been working on a line of integrated business software that is available on both 8- and 16-bit systems. The products are functionally integrated; that is, data can be shared among products. In addition, under operating systems like Digital Research's Concurrent CP/M, these programs can share data via a small satellite program used to facilitate communication. Three products, Profitplan, Microplan, and Graphplan, allow various levels of spreadsheet and graphing capabilities. A consolidation module allows data to be combined from various sources. Memoplan is a word processor, Docuplan is a sophisticated document formatter, and Fileplan is a data entry and management system. In particular, data from several sources can be printed in a single report, and information from a database can be transferred to a spreadsheet.

Because of their limitations, 8-bit machines offer functionally integrated programs only. Although software for 8-bit computers may not provide concurrency or shared technology, software developers continue to increase the amount of functional integration in their packages. You may have to insert and remove disks more often, but you will still get products to "talk" to each other.

Further Integration

Software development produces interesting products, but the work in integration continually uncovers a need for greater integration than existing products supply. The new, more powerful 16-bit microcomputers open a Pandora's box of promises and problems, but at least they move us one step closer to solving those dream computer tasks.■

Dash Chang is president of Chang Laboratories (5300 Stevens Creek Blvd., Suite 200, San Jose, CA 95129-1088). He has a B.S. in electrical engineering from MIT and an M.B.A. from Stanford University.

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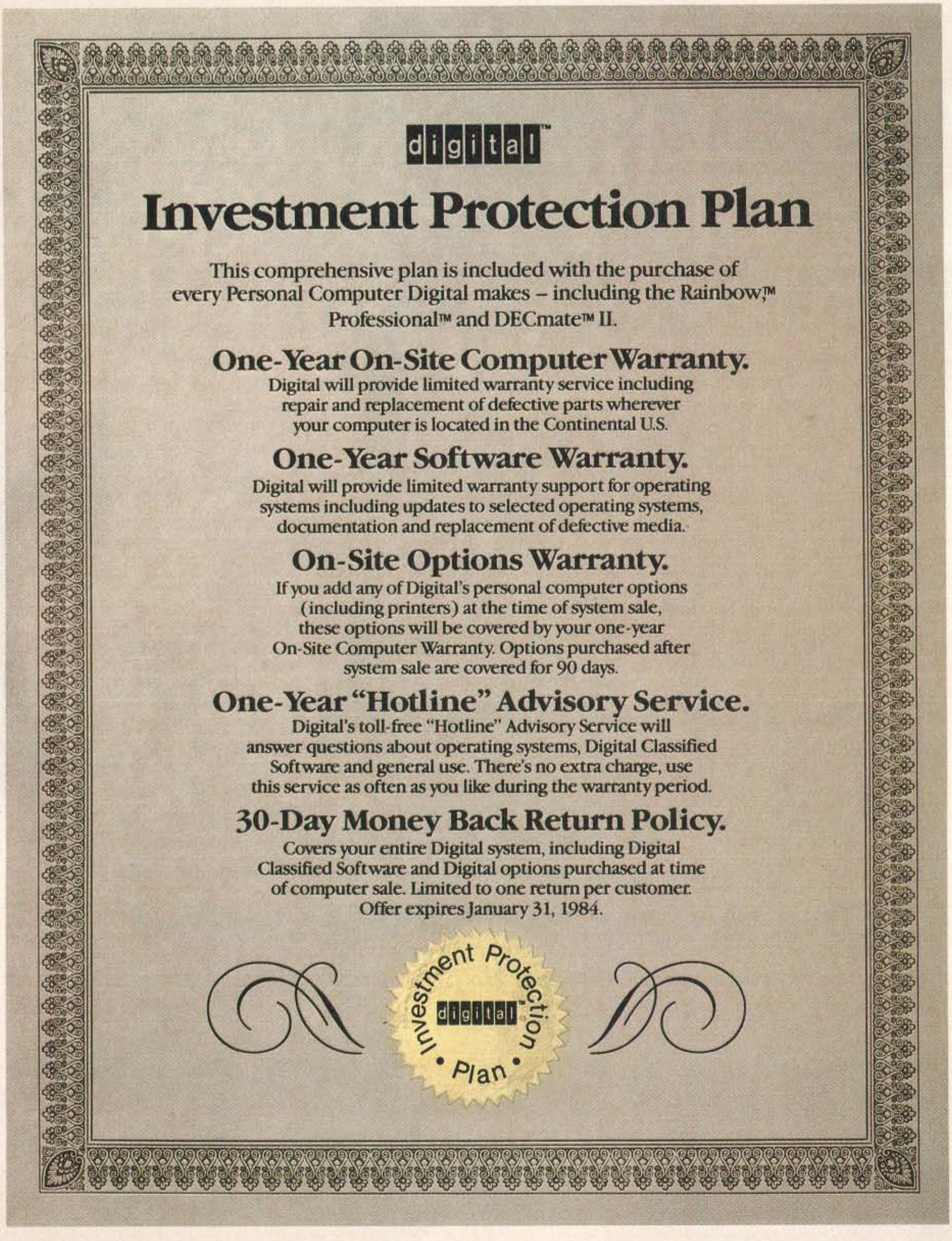

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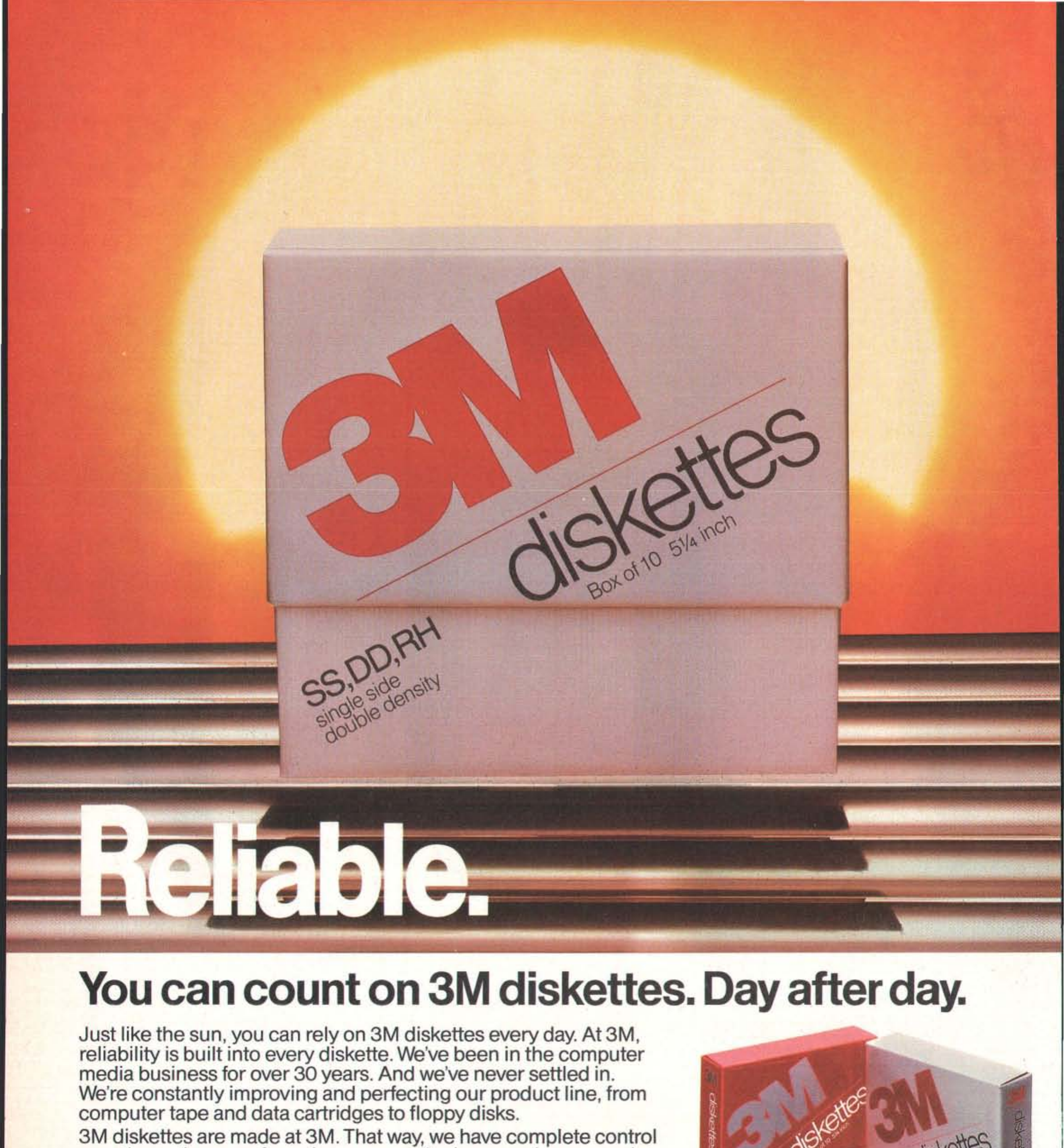

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Presentation and Form in User-Interface Architecture

Architectural form and the interrelationship of software functions suggest guidelines for developing user interfaces

by John M. Carroll

Among the many trends in end-user applications software, two seem to contradict one another. On one hand, software is getting more complex: word processors a few years ago were seen as a thrilling glimpse of the future. But now they're being superseded by office workstations with more powerful and diverse capabilities such as the availability of alternate fonts for text, voice annotation, and high-quality graphics.

On the other hand, momentum is gathering toward increased software usability. Emphasis on ease of learning and use is directed at that recently discovered software component, the user interface. Unfortunately, these two trends can often be at odds. If system capabilities were constant, the quality of user interfaces would certainly progress. For even without a deeply principled understanding of human-computer interaction, the problem of software complexity versus ease of use could be attacked on a case-by-case basis. But as functional complexity increases, this kind of approach is less feasible.

The upshot of the conflict is that people using end-user systems frequently lose track of where they are and what they are trying to do. They can produce tangles of errors and ad hoc recovery behaviors that no manual (on-line or off) can anticipate or analyze (see reference 5). This is not just an issue for novices, as more experienced users, perhaps overwhelmed by available functions, often have trouble exceeding a mediocre performance level (see reference 10).

As software becomes more complex, people frequently lose track of where they are and what they are trying to do.

Presentation vs. Form

We will discuss here two directions we can pursue to achieve quality in the user interface. At the level of architectural presentation we are concerned with the specific nature of interface elements—the objects and actions that make up the interface and its concepts—often called "metaphors," which organize these primitive elements. The presentation of the function through interface elements (icons, menus) can be addressed, I believe, only on a case-by-case basis.

An example of a specific architectural-presentation case is the contrast between graphically conveyed interface metaphors, as in the use of display icons for actions and objects, and nongraphically conveyed interface metaphors, as in the use of metaphoric vocabulary for these actions and objects (e.g., mail, print, document, file). Other examples include the availability and nature of command-driven dialogue, of prompted specifications and/or selections via menus, and of status and error feedback.

A second direction we can pursue concerns architectural form. The focus here is on how system functions are interrelated in typical user scenarios, but not specifically on how each is represented to the user in the interface. This formal organization in the interface (or architectural form, as we call it) can be addressed as a general-level issue, unlike presentation.

One general-level issue of architectural form, for example, is the contextual dependence of various functions. In an interface with high contextual dependence, the range of available functions is fixed strictly by the mode the user is in. The hierarchical access of functions, typical of menu interfaces, is a common example of contextual dependence (for example, property sheets in the Star-type interface; see reference 11). In an interface with low contextual dependence, any function can be accessed from any mode, in the same manner and with the same effects.

The distinction between architectural form and architectural presentation has important implications for the organization of research efforts on user-interface issues and in particular for the development of user-interface guidelines. For example, I have found that there are principles of architectural form that can be broken down into guidelines, but there are no such principles of architectural presentation. I recognize that this claim will be controversial and that my arguments for it will be incomplete. My purpose here, however, is to initiate and focus controversy, not to settle it.

Consider the examples mentioned earlier. It seems that the issue of contextual dependence can be simply and generally resolved by following this guideline: maximize contextual dependence in a user interface to facilitate interaction in typical user scenarios. As far as I know, this optimally eases system learning and use. The only trade-off is that atypical user scenarios would require circumventing contextual dependence. (The best we can ever do is the greatest good for the greatest number.)

But now consider the question of whether an interface metaphor should be couched as a display icon or as a labeled softkey. I don't think there is or will be a general principle to cover this case. In the balance of this article, I will examine cases of architectural form and presentation.

Architectural Form

Our research examined techniques for "staging" the presentation of system functions to new users. A staged user-interface architecture makes it possible to turn off functional layers so that the basic applications software can be run by the user with no frills, but the advanced functions can easily be engaged when requested. A user interface designed this way, with staged access, i.e., accessible in layers of complexity, can always be conveniently made simpler or more complex by merely turning functional layers off or on.

There are two reasons why staging access to sophisticated functions might be a good idea: first, it deals with the impact that increasing functional complexity can have on interface quality. The remedy is to block off enough of the function to make the system seem simple. Indeed, the pitfall of prematurely and inappropriately accessing advanced functions is a common new-user error and may lay the groundwork for timidity on the part of more experienced users when it comes to exploring advanced capabilities.

The Training System users were able to begin concrete work in less than half the time of the group using the Full System.

Second, by having the advanced functions available, this scheme provides a bridge for the user between understanding the basic functions and mastering the complete applications package.

To experiment with this idea, we designed a series of modifications in the user interface of a commercial word-processing system. David Boor and I managed to define a simpler level of functionality, which included only document creation, revision, and printing functions and which specifically blocked the seven or eight most devastating new-user errors that we had observed in a study of people trying to learn the full system. Essentially, we imposed an alternate architectural form on the system by brute force. This is the basis of the Training System.

Physically, the Training System looked exactly like the Full System, the one with the advanced functions. All the menus and other displays were exactly the same. However, when a user selected one of the error-provocative choices, options, or functions we had isolated, the Training System displayed the message "X is not available on the Training System." (X was the name of the selection.) The error consequences had been blocked, and the user was immediately free to make another selection. The user could see the advanced function and even try it—only to be told it was not yet available, but the user would not suffer the penalty such self-initiative often carries. In the Full System in the same situation, the user's selection would have triggered an actual function and in most cases would have led to trouble quickly.

Subsequently, I experimented with the Training System in collaboration with Caroline Carrithers, Jim Ford, Georgia Gibson, and Penny Smith-Kerker, in a series of studies reported and to-be-reported elsewhere (see reference 3). Part of what we found is good but not altogether surprising news: novices can learn basic word-processing skills several times faster if they don't have to spend time recovering from the errors of prematurely and inappropriately accessing advanced system functions. In particular, the Training System users were able to reliably get to the typing display and begin concrete work in less than half the time of the best-performing group of learners using the Full System.

There was evidence that this advantage is more than merely a matter of reducing error time. The Training System users, at the end of our experiment, could type and print out a simple letter more than twice as fast as the Full System users could. The

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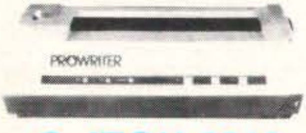

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Training System users reduced the proportion of their time spent on errors almost 50 percent compared to the Full System users over the course of the experiment. And more than 90 percent of this improvement resulted from their spending less time on the errors that were not blocked in the Training System itself. Hence, the advantage of the Training System is not merely a matter of blocking errors, then observing that people spend less time on them.

At the end of the experiment, we administered a system-concepts test and a work-attitude test to our experimental subjects. The Training System people did better on both tests, indicating that they had learned more about the system and that they felt better about work in general after the experience.

We have learned some fairly specific lessons with regard to the design of training systems, in general, for computer users. The novices using our Training System were given opportunities to see where the advanced functions were and to make errors, but they were protected from the direct consequences and side effects of making the errors. Nevertheless, they learned to discern errors more successfully than their Full System counterparts. The Full System learners were punished more for making errors, but their learning was impaired rather than facilitated relative to the Training System group. The simple implication is that negative reinforcement has no useful role in the user interface.

The second lesson we learned from this work pertains more to the issue of architectural form. The system we studied was derived from a commercial system by ad hoc surgery—long after the original design had been set in silicon. We can imagine, however, that when the original architecture of a machine is developed, provisions can be made for the sort of function subsetting we had to graft on by brute force. This amounts to a user-interface guideline that dictates that the core of an applications package be a coherent package—and, in turn, perhaps that the secondary function, along with the core, constitute a

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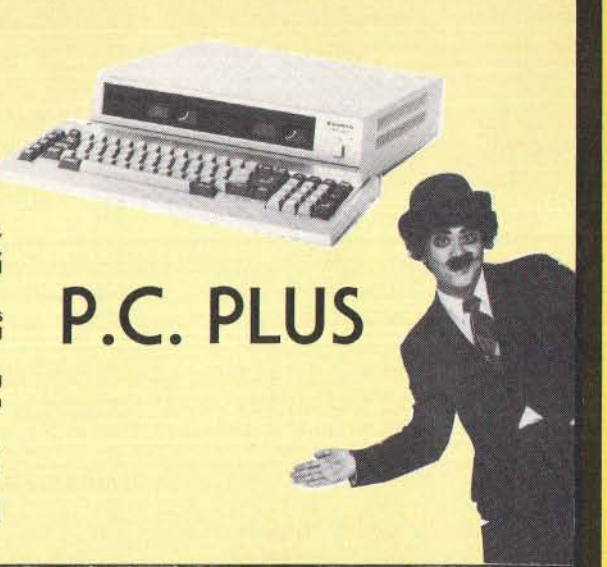

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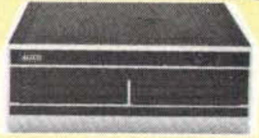

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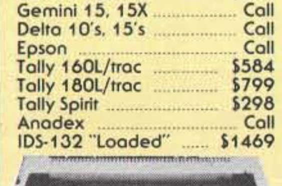

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coherent application, and so on. This conclusion has two properties: first, empirical evidence supports it; second, the recommendation it makes is simple and general.

A question that remains is how users will progress from the core functions all the way to the full-function system. In the real world, experienced users sometimes limit themselves to subsets and never become experts on systems they use routinely (see reference 10). Our simple case study had only two levels of system complexity, and in the case in which we examined users switching from one level to the next, they were told explicitly to switch. However, the intent in the Training System is to motivate the user to see increasing but manageable functional complexity as a challenge.

Architectural Presentation

Architectural presentation is a design domain par excellence; as such, it is not amenable to deductive analysis (see reference 6). Rather, it is fundamentally a matter of iteratively refining and developing a set of idiosyncracies.

Unfortunately, there can be no demonstrable arguments either way for such a claim. But that does not diminish the importance of the question, because even a tentative determination could help organize and allocate effort in user-interface development. I will illustrate the argument by discussing some recent interface metaphors for office systems.

User-interface metaphors build upon what a user already knows.

Most simply, the motivation for developing user-interface metaphors is to build on what the user already knows and reducing what would be hard to understand. For example, a large proportion of intended users are professional typists, who know a lot about typewriting but not necessarily about computers. Analogous points can be made for potential users of electronic spreadsheets and various other applications. Such observations suggest a simple design idea that has been very successfully exploited: help people learn and use unique systems by inviting them—via the interface—to engage their prior noncomputer knowledge (see reference 7). The current popularity of interfaces that are deliberate metaphors of typewriters, spreadsheets, and desktops is good evidence that this approach is on the right track.

However, I question whether the issue of metaphors is a simple one. There are two reasons for my concern. First, metaphors are inevitable in human thought, and, while they can be a source of insight and savings, they can as often be a source of interference and confusion. When we focus on success stories that contend, for example, that a word processor is a typewriter, we overlook the many classic examples of metaphor-induced troubles. Psychologists even have a special term to refer to the interference of prior knowledge

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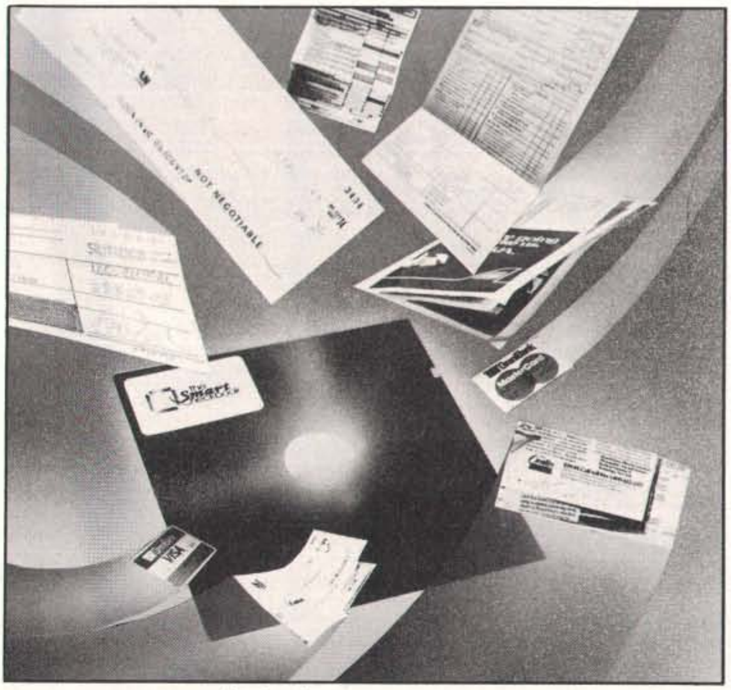

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An experiment in which people were asked to mount candles on a vertical screen provides an example (see reference 1). The subjects were each given a small cardboard box containing candles, thumbtacks, and matches. A correct solution is to mount the candles on the boxes (by melting a little wax) and then to mount the boxes on the screen (with the thumbtacks). Because boxes are typically containers, not platforms, most of the participants did not use them to support the candles. Their preconceived notions interfered with the required insight. When the materials for the problem were presented to the subjects in the boxes (reinforcing the container interpretation), only 10 percent of the participants could solve the problem. When the materials were provided with empty boxes, however, almost 90 percent solved the problem.

Even the typewriter metaphor has its problematic side. Users we have studied were often quite confused by the fact that such keys as the Spacebar, Backspace, and Carriage Return insert blank spaces and line breaks instead of merely moving the typing point (as on a real typewriter). People often balk at instructions such as "backspace to erase" or "type to insert." And this can cost them failure and frustration. Users often try to change margins and tabs when doing so is needless because of system defaults and dangerous because of the risk of getting tangled in advanced functions (see reference 8). But the point is not to avoid metaphors, for this is not possible. Engaging prior knowledge in the service of present behavior and thought is a fundamental cognitive process.

The second reason interface metaphors may never become a matter of simple and general principles is that they often act as conceptual aids, both mismatching as well as matching their targets. A computer, for instance, is not literally a typewriter. Pressing a computer's keys elicits glowing dots on a TV screen rather than lines of ink on a paper—really very different effects. And typing over characters on a computer screen replaces those characters or inserts new ones, although both outcomes are unpredictable on the basis of literal metaphor projection. Indeed, given a simple view of the use of metaphors, it is remarkable that neither of these metaphor mismatches has a very troubling consequence for learners. Encountering these inequalities can, in fact, be an opportunity for developing an enhanced understanding of the electronic medium, e.g., the concept of dynamic storage (see reference 4).

These two properties of metaphors raise a host of questions. When is the metaphor trade-off favorable? When will metaphor mismatches be cognitively stimulating? We cannot resolve these questions in a general way, nor can we dismiss them, for aspects of metaphors pervade virtually all thought and certainly any user interface. The very notion of a user interface implies that what the user is seeing and conceptualizing is something at least one step removed from what the system is really doing. Adding iconic objects and actions may make

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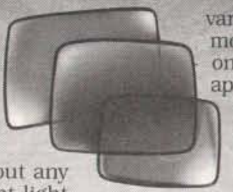

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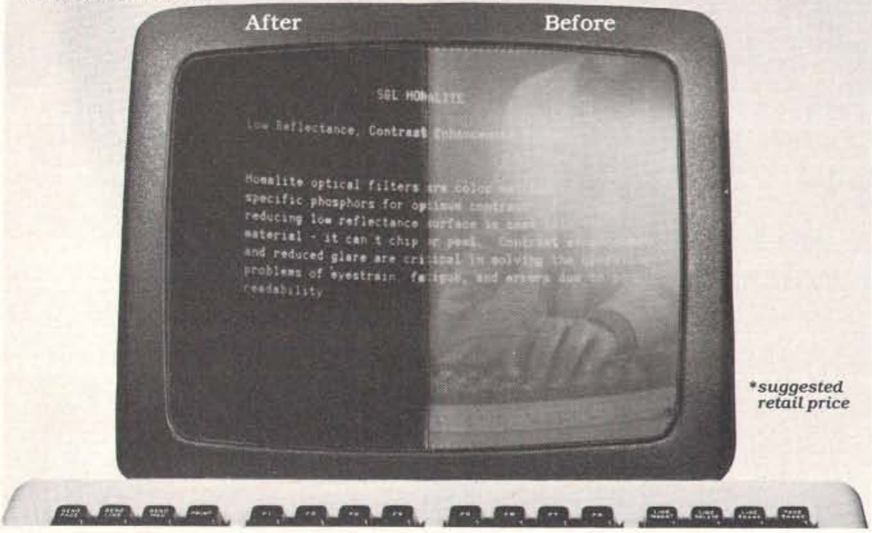

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the desktop metaphor more explicit, but interface icons are not necessary to suggest the metaphor in the first place. Merely describing a system as an "office-application system" brings to mind rich and diverse physical office metaphors.

Having recognized that user-interface metaphors are complex and unavoidable design trade-offs, we cannot say much more than "try some out, test them, and try some more." For example, suppose that a document removed from a folder (directory) to be edited is not returned to the folder after editing. The office metaphor suggests that the document should then be "left out" (e.g., on a metaphorical desktop), to be returned to the folder only when the user explicitly moves it there. But what about printing the document? Suppose that a document removed from a folder for printing is not returned to the folder afterwards. Should it remain on the metaphorical printer's metaphorical paper table? Or should the printed document be automatically refiled?

I think both choices are unacceptable. If the document is automatically refiled, the consistency between editing and printing is compromised. If it is not automatically refiled, however, it will likely be forgotten and left in the printer. After all, when a document is sent to be printed, the user's attention ultimately shifts to the printer (not an icon or object label, but the actual equipment). What happens when the next document is left in the printer? We can find solutions to such architectural-presentation issues if we wish; however, these well-reasoned solutions will not always be appropriate. The trade-offs and interrelations are too rich and subtle; too often the key factors are completely idiosyncratic to a particular system or application. When one problem is solved, another, whose very existence depends on the prior solution, appears.

Architectural form, it seems to me, is very much a matter of general principles and could provide the user-interface guidelines for which every designer longs. For this reason, it may make sense to direct research on matters of architectural form at general-level principles. Architectural presentation, however, seems less amenable to such a treatment. Presentation issues, I think, will remain case-by-case problems to be resolved by prototyping and user testing. If this world view is correct, then the distinction between architectural form and presentation could be an important guide in planning research on the quality of user interfaces.■

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John Carroll is a research staff member at IBM's Thomas J. Watson Research Center (POB 218, Yorktown Heights, NY 10598).

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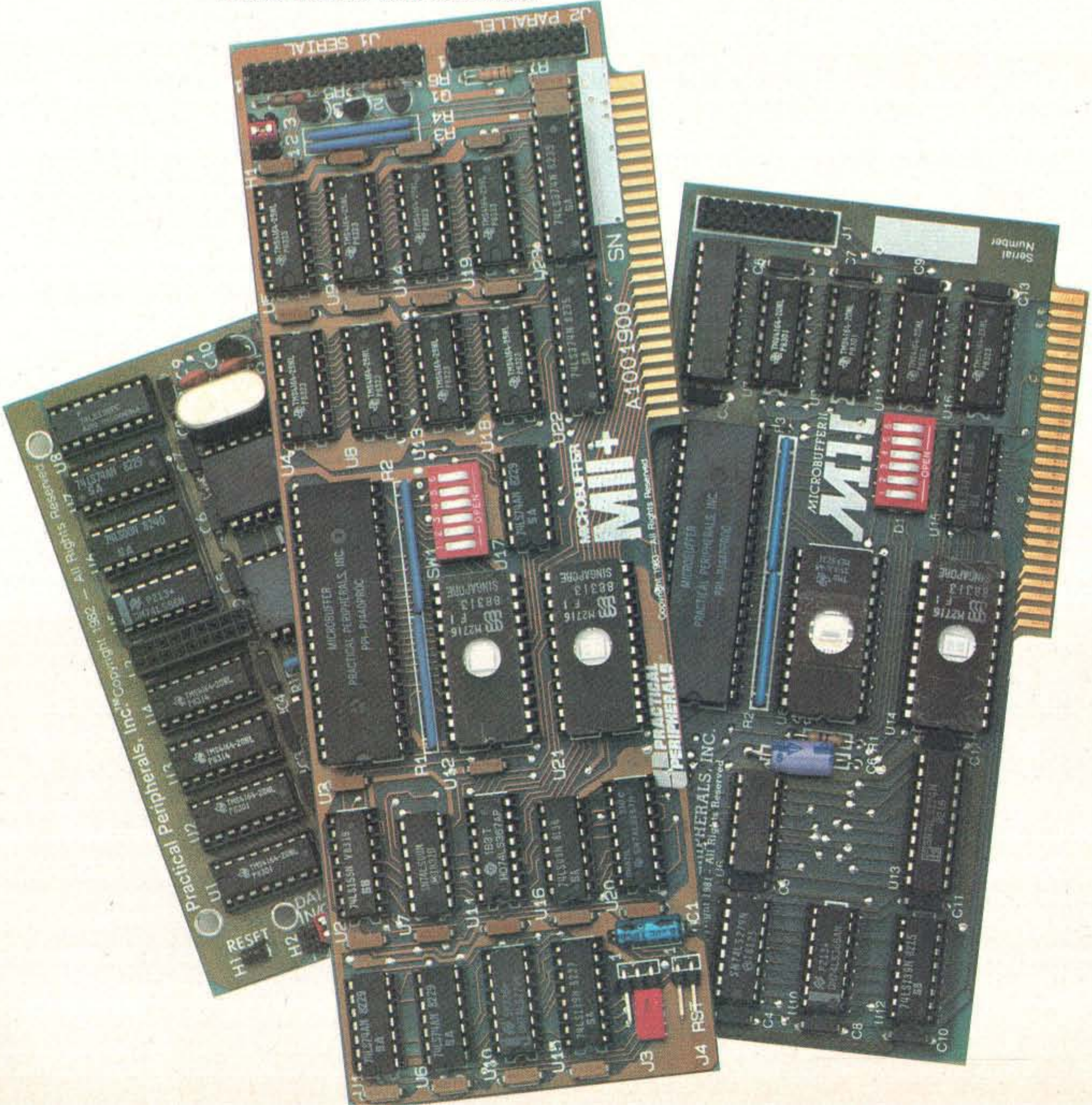

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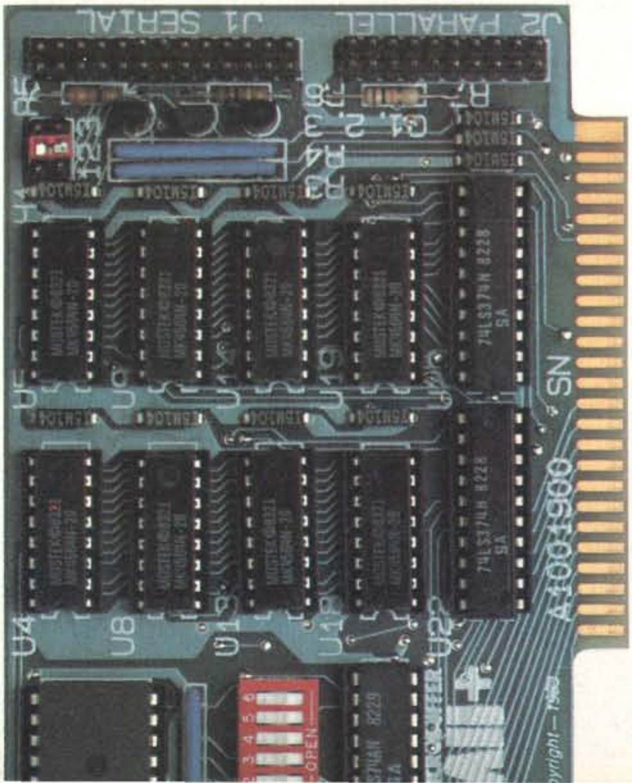

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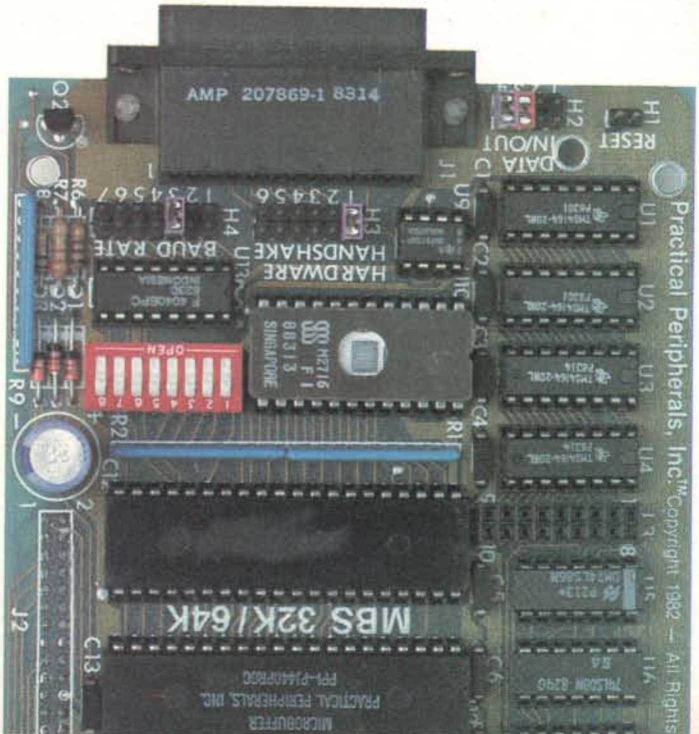

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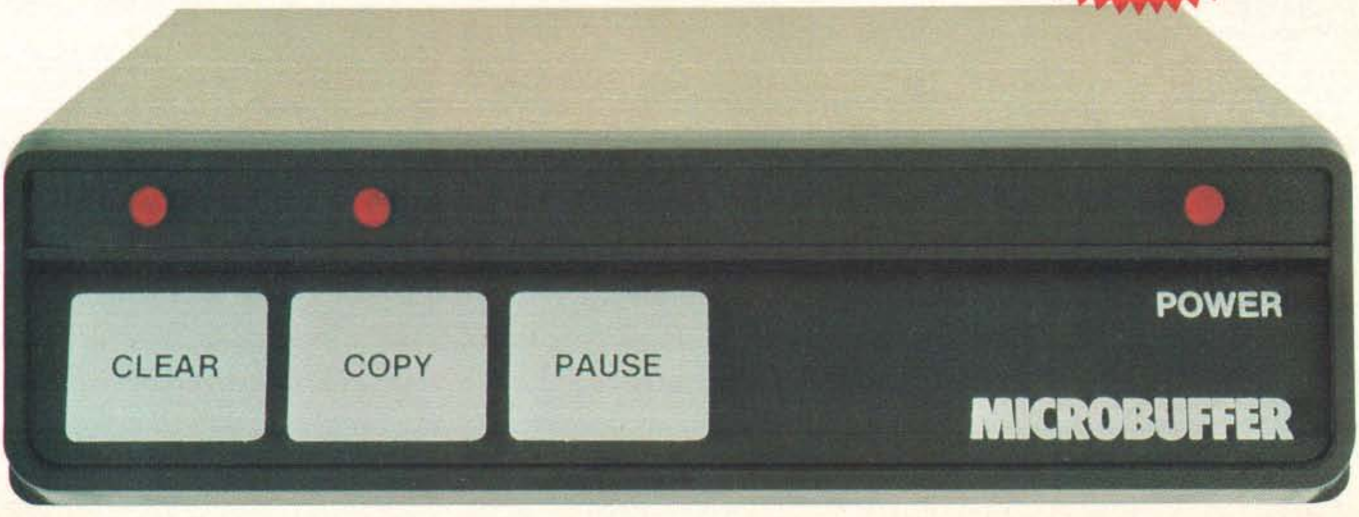

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Why Is Software So Hard to Use?

So far, the "ease of use" idea has generated more advertising copy than easy-to-use software

by Sam Edwards

I divide microcomputer owners into two groups: those who use computers as tools to get a job done and those who see them as neat toys to be played with for their own sake. I call the first group users and the second hackers. I also have a confession to make: even though I am a computer programmer, both my feet are firmly planted in the users' camp. I don't enjoy complexity for its own sake. I dip into the innards of my personal computer by necessity, not curiosity. I use computers because they get my job done, but I don't really like them very much.

If you want to find out if you are a user or a hacker, compare figures 1a and 1b, screen displays you would see upon signing off from two imaginary computer systems. If you find yourself enchanted by the latter, read no further. You are a hacker, and this article is not written for you.

Software Is Not Easy to Use

Now that we've gotten rid of the hackers, let's first agree, fellow users, that most software products are not easy to use. Even if you number yourself among the fortunate few who have experienced no problems installing, learning, and using your software, I am sure you know of friends with horror stories. They complain about programs that require an electrical engineering degree to configure to your computer; manuals that explain nothing, or far too much; error messages that appear when you've done nothing to be ashamed of and that aren't documented ("So I pressed the Tab key,

(1a)

```
END OF SESSION
```

(1b)

```
                        END OF SESSION


CONNECT TIME: 00:12.34      # DISK ACCESSES    : 456
SESSION TIME: 00:11.27      # DISK UPDATES     :  98
CPU TIME    : 00:01.54      # DISK RETRIES     :   0

MAXIMUM PATH  : 4.7         # KEYSTROKES       : 315
MINIMUM PATH  : 1.1         # COMMANDS         :  14
AVERAGE PATH  : 2.6         # CHARS DISPLAYED: 847
STD. DEVIATION: 0.7         AVG. DISPLAY RATE:  43/SEC.

LOAD POINT    : 00C8        ACTIVE MEMORY      : 256K
ENTRY POINT   : 6A77        % UTILIZATION      :  14

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Figure 1: *If you prefer 1a to 1b, I'd call you a user. Read on. If you prefer 1b to 1a, you're probably a hacker.*

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and the screen displayed INTERNAL ERROR 315, and my computer started to beep at me, and it just kept beeping and beeping..."); and applications that lead you down a decision tree into a cul-de-sac where your only exit is the power switch. The point is that not only is most software difficult to use, but it's the software's fault and not yours. Many users unfairly blame themselves for the deficiencies of their software. I want you to stand up now and say out loud, "My software is not easy to use, and I am not a dummy." There, I bet you feel a lot better.

Admittedly, the "ease of use" idea has caught the software industry's attention, but so far it has generated mainly advertising copy. Rare indeed is the advertisement that doesn't proclaim its program Easy to Use or User Friendly. Investigate these claims and you will usually discover just another hard-to-use product with a bunch of lessons and help screens tacked on. In fact, some popular software is so hard to use that an entire subindustry has sprung up to help the user figure out how to use it. A recent microcomputer magazine had 11 advertisements for seminars, keyboard templates, on-line tutorials, program interfaces, and so on, all designed to make money off of people who bought name-brand software and then found it too difficult to use.

Creating easy-to-use software requires a good model, lots of attention to detail, and a constant effort to simplify.

Easy Is Difficult

One reason why so little easy-to-use software exists is that it is very difficult to create. Creating easy-to-use software requires a good model, lots of attention to detail, and a constant effort to simplify. (It also requires a lot of code. John Page, the creator of PFS:FILE, estimates that fully half of FILE's code is devoted to the user interface.) It is easy to add "just one more" feature but difficult to integrate it smoothly with existing features. It is easy to provide an application with lots of options but difficult to avoid presenting those options to the user in formidable lists of menu choices, cursor-control keys, embedded printer commands, and so on. It is easy to expose the internal structure of a program as a model the user must understand but much more difficult to present a model with which the user is familiar.

Another reason software is not easy to use is that some potential customers won't buy it if it is. Some of these potential customers suffer from the Big System Syndrome, a carryover from the days when computers were big and complicated and maintained by a priesthood of white-coated computer operators in special air-conditioned rooms. Today's Big System Syndrome sufferers derive pleasure in direct proportion to their software's complexity and obtuseness. There are others who feel somehow cheated if the programs they buy don't fill their screens, beep their speakers, and whir their disks to the maximum. They want their money's worth. Finally, some users equate difficulty with sophistication. These are the people who waited until IBM legitimized the microcomputer industry before they bought their personal computers; their image as professionals is at stake, and they can't risk "easy" software destroying that image.

The Feature Chase

Software is not easy to use mainly because the people who write it, market it, review it, and sell it aren't really interested in how easy it is to use. What programmers care about is how much it can do. In the inexorable drive toward more and more features, the players have lost sight of the software's only purpose: to get the job done with as little fuss as possible.

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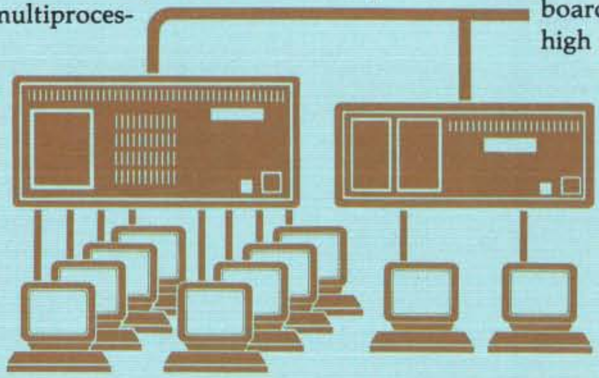

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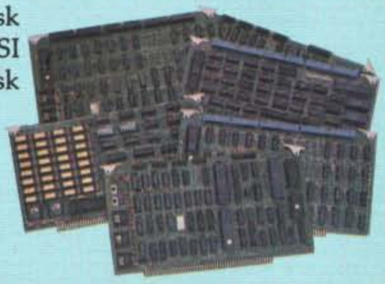

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shell sorts, things he understands and loves. When fellow programmers ask him about his current project, he tells them about his neat data-compaction scheme and how he got it to fit in only 2K bytes. When they ask for a demo, he'll show them some exotic feature that no competitor's product offers ("Watch this: just press Control-V,X and the Escape key, and bingo! Your subscript is now underlined.")

Immersed in technical details and surrounded by like-minded people, the programmer quite naturally expects the end user to share his enthusiasm for the technical and the complicated. And so, little by little, technical details surface for the user's admiration. The programmer's spelling checker now tells what percentage of the words in the checked document appear exactly once. His database program now reports the average number of disk seeks per record accessed (it's the lowest average in the industry!). A chapter is added to his spreadsheet program's manual explaining in complete detail the format for the storage of real numbers (an elegant scheme; it should be shared with all mankind).

But the programmer shouldn't bear all the blame for his program's creeping elegance. The marketing department of his company steadily feeds him advice during the product's development, and the advice is always More Features. Any feature the programmer hasn't included that the competitor's program includes is pointed out, and it is easier for the programmer to add it than argue to eliminate it. After all, that's what he's paid for, right? There is also the unstated challenge to his ego ("Well, if it's too difficult..."). Of course, any features the programmer includes that the competition has neglected are looked upon by the marketing department as just so much gravy.

After investing all that time and effort in adding features that the competition doesn't have, it would be silly not to point out their uniqueness in product advertisements. So a matrix is worked up with features along one axis and the product versus its competition along the other axis. (The features listed are mainly those that the competition lacks.) Unfortunately, the ad does not address the only question that really matters: will the product do the job for you without any fuss?

When the software reviewer enters the picture, his assignment often is to compare the programmer's creation with similar packages from competitors. If he doesn't have enough time to actually use all of the products he is reviewing (which is very often the case), he makes his own matrix of features versus programs, just like in the ads. I've got a whole file of these reviews. They are always entitled "<magazine name> Reviews <however many> of the Most Popular <spreadsheet/word-processing/ home-accounting> Programs for the <computer name>." Reviews like this are generally quite useless. After reading across the rows and down the columns, can you really say which product is best for you?

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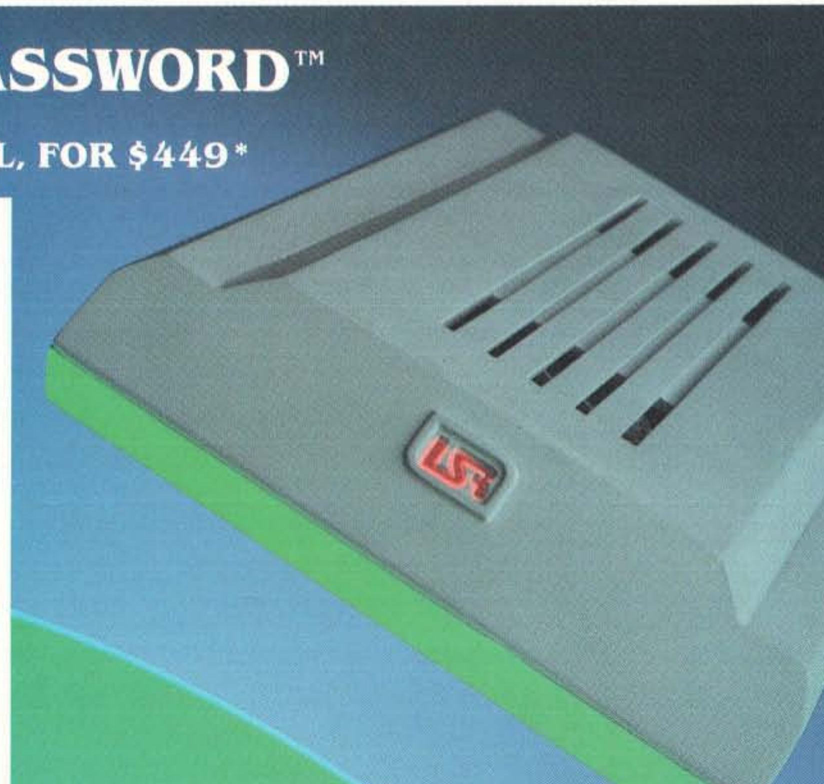

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each category for each computer he sells. How can he choose which ones? He reads the ads, dealer promos, and software reviews. Since every product claims to be easy to use, he concentrates on what each product can do, assuming that, all other things being equal, the more a product can do, the better it is. Hence he stocks those products that have the most features, confirming the programmer's wisdom in putting those extra features in and encouraging him to include even more in future versions.

The unfortunate result of this feature chase is that the user ends up with a program that does everything in the world except (you guessed it) get the job done with no fuss.

What Makes Software Easy to Use?

Easy-to-use software gets the job done with no fuss. That's because it stays out of your way by not drawing attention to itself and by offering you only what you need to know. It lets you concentrate on your work and not on using the program. Rather than try to be all things to all people, it contents itself with meeting the essential needs of most people.

Easy-to-use software does what you expect it to do. Its responses to your commands are natural and unexceptional. As you work with it, it may elicit from you an occasional murmur of contentment but never a cry of amazement, grief, or profanity. It satisfies what people in my company call the Principle of Least Astonishment.

Easy-to-use software offers you less. The thinner the manual, the less you'll have to read to learn the program. The fewer the choices on the menus and prompt lines, the less you'll have to think about before making your choices. The less a program does, the fewer things can go wrong with it (and, most probably, the less it costs). For me, less denotes simple, clean, uncluttered, and uncomplicated.

A Good Model

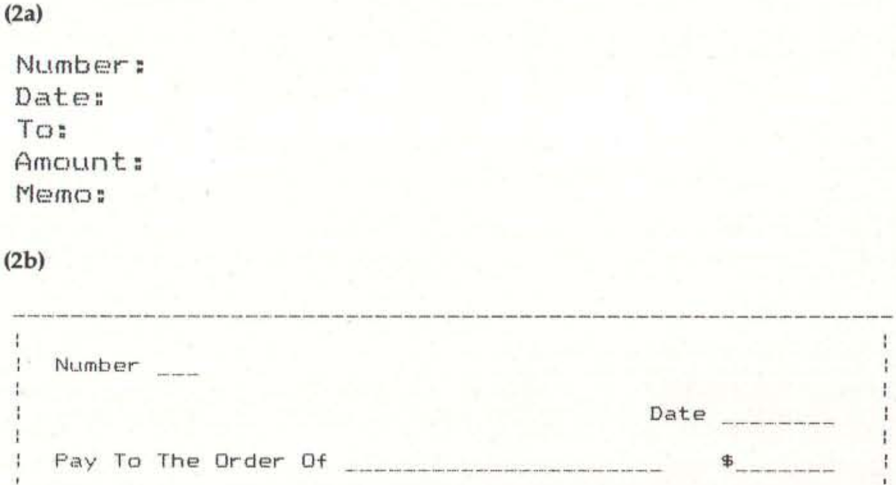
A good software product uses models of things you are already familiar with. If you glance at figure 2a, a screen from an imaginary home-budgeting program, you might not be sure what it is for. If, however, I rearrange the prompts and add a border, its purpose becomes self-evident (see figure 2b).

I've seen many examples lately of databases that use a screen display of a filing cabinet as their model. This model can be extended to have the chosen drawer open up and the folders inside pop up for your inspection and choice. By using such a familiar object as a model, this program does away with any need to explain "master" and "detail" data fields or whatever the internal equivalents are for the drawers and the folders. Apple's Lisa computer comes with a program that uses a hand calculator as a model. You "press" its "keys" by selecting them with the mouse. This program's virtue does not lie in its efficiency (an actual hand calculator is faster to use) but in its familiarity; you don't need to read a manual or a help screen to find out how it works.

One danger with models is that in their effort to imitate the familiar object, they may imitate the object's limitations as well. A word processor patterned after a typewriter so slavishly that you see a graphical image of the type ball swing up each time you type a character may be comfortably familiar but may eventually drive you crazy.

One of the most familiar objects of home and office is also one of the most difficult to model successfully: a piece of paper. Programs seldom show one of paper's most obvious characteristics: its edges. Nor do programs simulate the freedom of using a pencil or typewriter to write anywhere on the paper. Cut-and-paste operations rarely bear any resemblance to the cutting and pasting of real paper.

The sheet-of-paper model is ideal for a database program in which each screen represents a form to fill out. With care, the same model can also be used to represent menus and other command screens, thus eliminating the need for the user to learn different procedures for data entry and command entry. A popular alternative to the sheet-of-paper model for command entry is the sequential model; you select one item from a list, which in turn offers you a secondary list, and so on, until you have reached the list containing the item



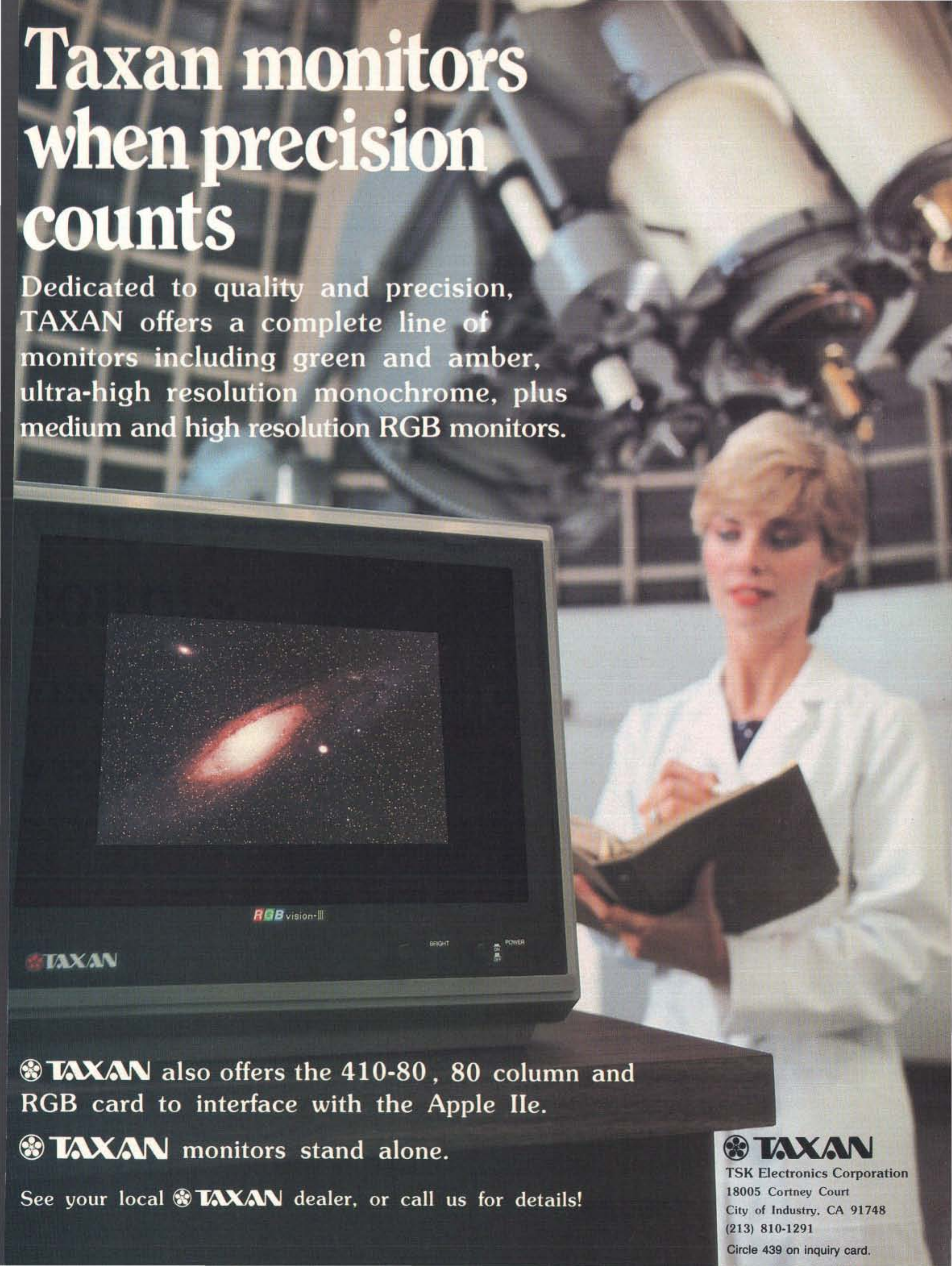
(2a)

```
Number:
Date:
To:
Amount:
Memo:
```

(2b)

```
-------------------------------------------------------------
:                                                           :
:  Number ___                                               :
:                                                           :
:                                        Date ________      :
:                                                           :
:  Pay To The Order Of ______________________    $_______   :
:                                                           :
:                                                           :
:  ____________________________________________Dollars      :
:                                                           :
:                                                           :
:  Memo ________               _________________________    :
:                                                           :
-------------------------------------------------------------
```

Figure 2: *An unclear screen from an imaginary home-budgeting program (a). With prompts and a border, the purpose of the screen becomes self-evident (b).*



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you want to change.

With the sheet-of-paper model as employed by PFS:WRITE, you select the Define Page option of the main menu by typing 2, which brings up the Define Page Menu. You then move the cursor to the Left Margin item and type the new value over the old one.

The advantages of the sequential model are that it often requires fewer keystrokes to select an option and it need occupy only one line of the screen. The advantages of the sheet-of-paper model are that it enables you to examine and change many items at the same time; it has fewer levels of nesting, thus reducing the need for additional commands to "back up" the command tree; item names need not be artificially shortened to squeeze onto a single line; and item names and even graphical elements can be more freely used on the screen for greater comprehension.

Consistency

Consistency may be the single most important factor in determining a program's ease of use. Unless a program is totally consistent in its menu displays, error detection, warnings, keystroke assignments, help messages, option lists, and so on, its users will never be able to totally trust it or relax while they're using it.

Imagine that you have just acquired a program to help you with your home budgeting. Every time you press the F3 function key, the program moves the cursor to the command line. That's great—an easy rule to remember, and it doesn't get you into trouble. Then one day you try to edit an existing budget item. You enter the Edit subsystem, press F3 to get to the command line, and—whoops!—all of your item values have just been converted to French francs, just as the manual (which you never read) said would happen. Not only have you messed up your budget, you have also lost all confidence in the F3 key, even when you aren't in the Edit subsystem. From now on, every time you use your budgeting program, you will worry about it and wonder when it will foul

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you up again.

I occasionally use an operating system that requires a Q to quit the main menu, an E to move from the main menu to the editor, and, depending on what I have done in the editor, either a Q, E, or the Escape key to return to the main menu. The net result is that I must pause and worry a bit before typing Q, E, or the Escape key at any menu. A minor inconsistency has planted a seed of mistrust in the decision-making part of my brain. My peace of mind has been subtly disturbed.

Let me offer another example. Many word processors have a cursor-movement mode for moving the cursor anywhere in the document, an insert mode for typing new text, and a replace mode for typing over existing text. In the cursor-movement mode, you can use the cursor-movement keys, but you can't type text. In the insert mode, you can type text, but you can't use the cursor-movement keys. In the replace mode, you can type text, but only where there was text before, and you can't use the cursor-movement keys. In other words, you are never sure which keys are functional and which are not. Inconsistent keystroke definitions force you to devote more time to worrying about the software, leaving you with less time for your work.

PFS:WRITE's main menu expects you to enter a digit from 1 to 6, followed by pressing the F10 function key on the IBM PC to signify "I've filled out the menu; let's continue." I could have made the main menu even faster to fill out by having the program branch immediately after detecting a digit from 1 to 6, without waiting for the F10 key to be pressed. But that would be inconsistent with the way the other menus are handled. In the Define Page menu, for example, the F10 key is required because the program can't know when the user has finished filling out the menu. I chose consistency over efficiency here; the one keystroke I could have saved is not enough to compensate for the inconsistency of requiring the F10 key on all but the main menu.

Can consistency be carried too far?

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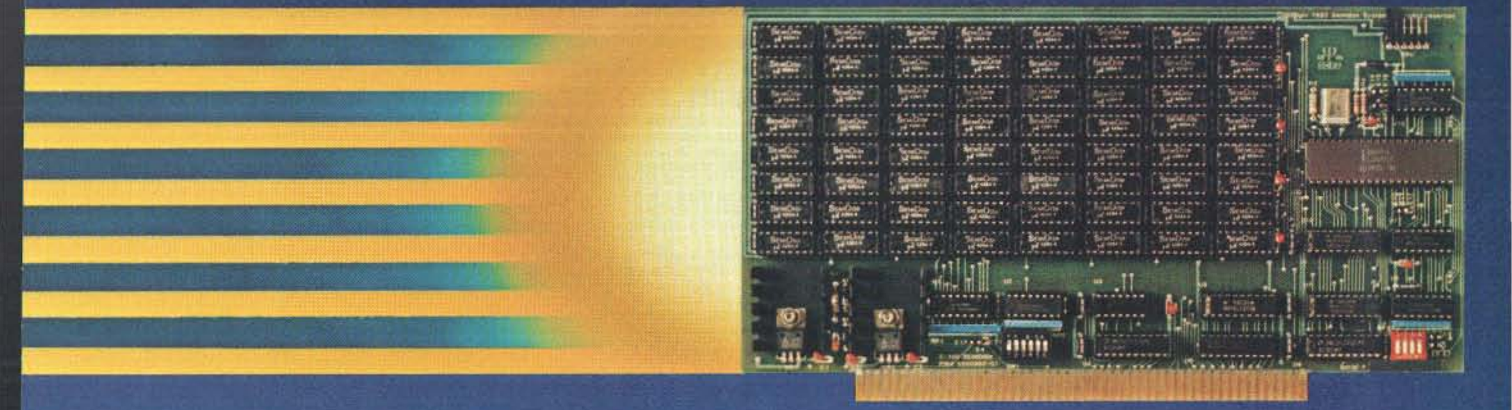

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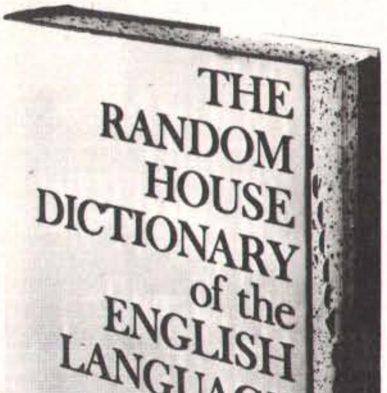

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Perhaps. PFS:WRITE moves the cursor to the beginning of the next line each time you press the Enter key, whether you are filling out a form or a menu. But as we just saw, WRITE's main menu requires you to type in only a one-digit number. Should the Enter key move the cursor to the beginning of the next line? That would be consistent, but it certainly doesn't help you fill out the main menu. Maybe it shouldn't do anything, or maybe it should mean "continue," just like the F10 key. These "trivial details" are the sorts of issues programmers must worry about if they decide to take ease of use seriously.

Consistency among several programs is perhaps more important than consistency within each separate program. If pressing the Escape key makes your word processor return to its main menu, your spreadsheet program undo the last command you entered, and your filing program remove the displayed form from your file, you are going to be awfully hesitant about ever pressing that key. Until independent software developers sit down together and agree on program conventions (which will never happen), you can minimize this problem by either buying integrated products that do the work of several individual products or buying the individual products from a single vendor who cares about consistency.

Product Integration

The integrated software you can buy off the shelves today looks like it was designed to cram the greatest number of features onto the fewest number of floppy disks and into the least amount of memory. This sort of packaging has imposed a certain amount of consistency within each integrated product (for example, it takes less code to make all prompt lines work the same way), but the products really aren't much easier to use than those they replaced. What they offer primarily are gains in speed and convenience. The disk shuffle you had to go through to get a graph printed with data from your spreadsheet program was so cumbersome and time-consuming that it was hardly worth the effort. Now, with graphing and spreadsheet functions in the same application, the process has become quite feasible.

This space restriction will disappear as computer memories become larger, disk capacities increase, and hard-disk prices fall. The next restriction programmers of integrated software will face is the limitations of their models. Any application that tries to do too many different things is going to have problems keeping its model from becoming distorted. The more reasonable alternative to one program that does all is a small number of programs, each of which does as much as it can within the confines of its own model. For example, one program modeled after a spreadsheet might provide row and column calculations, graphs, and reports, and another program modeled after a piece of paper might provide data storage, word processing, and spelling checking.

Summary

The new operating systems will make these integrated programs much nicer to use by imposing standards of data interchange, by permitting the simultaneous display of multiple applications on the same screen, and by permitting the rapid switching from one application to another. But ease of use is not an inevitable result of these developments. Multiple windows, high-resolution graphics, rapid task switching, and all the other wonderful technical wizardry coming our way can still leave us with messy screens, complicated decision trees, ambiguous prompts, inconsistent keystroke conventions, bad manuals, and all the other faults that have made today's software so difficult to use. Until programmers, advertisers, reviewers, dealers, and users decide they won't settle for anything less than easy-to-use software, it's not likely to appear on the shelves.■

Sam Edwards (2777 Pradera Way, Carmel, CA 93923) practices what he preaches as coauthor of the PFS:WRITE software package and in his position as software engineer at Software Publishing Corporation.

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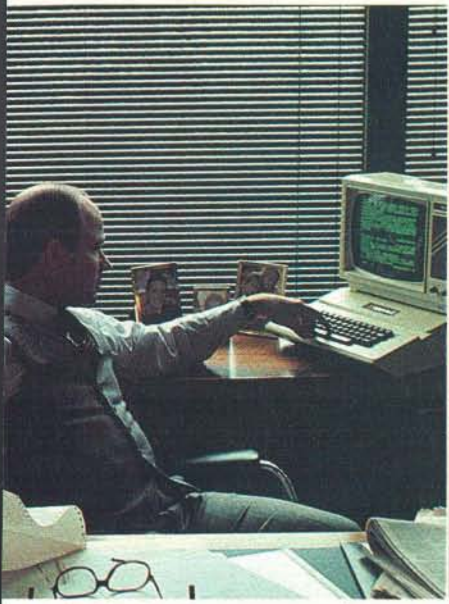
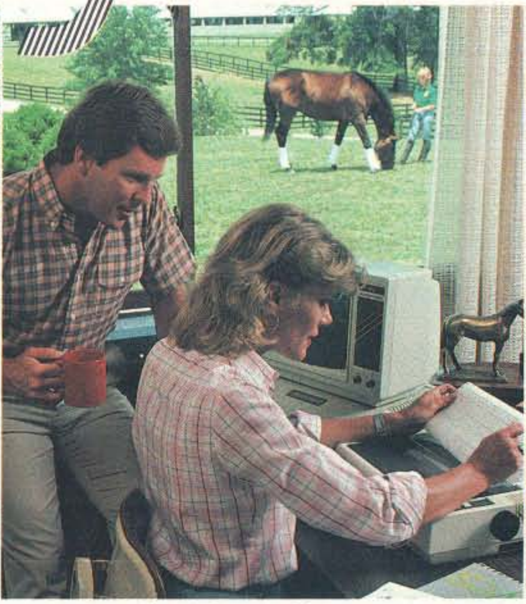
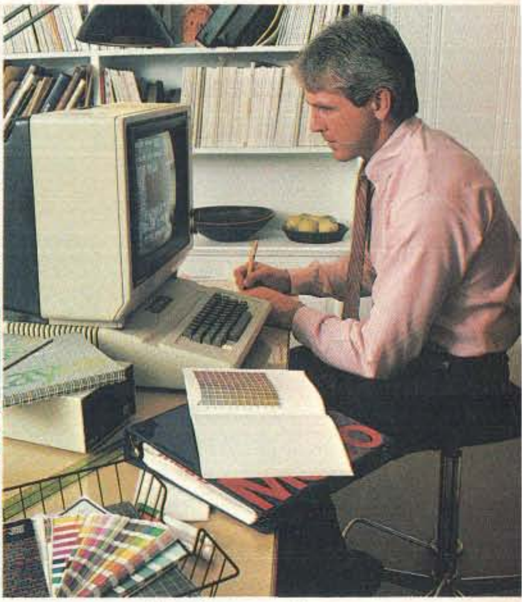


"Thanks for the prompt reply. Sure was a lot faster than waiting for the mail!"



"Gary: The pedigrees for next week's auction are as follows..."



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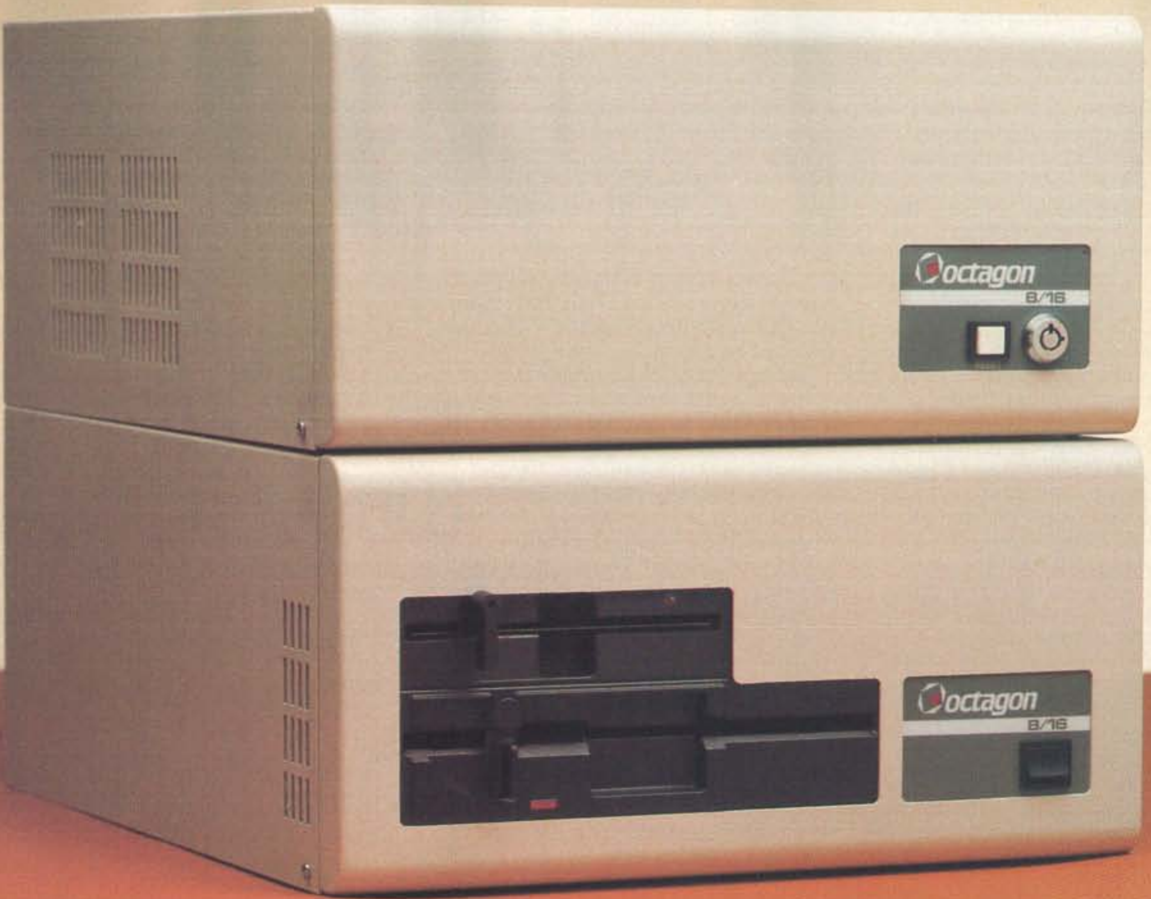

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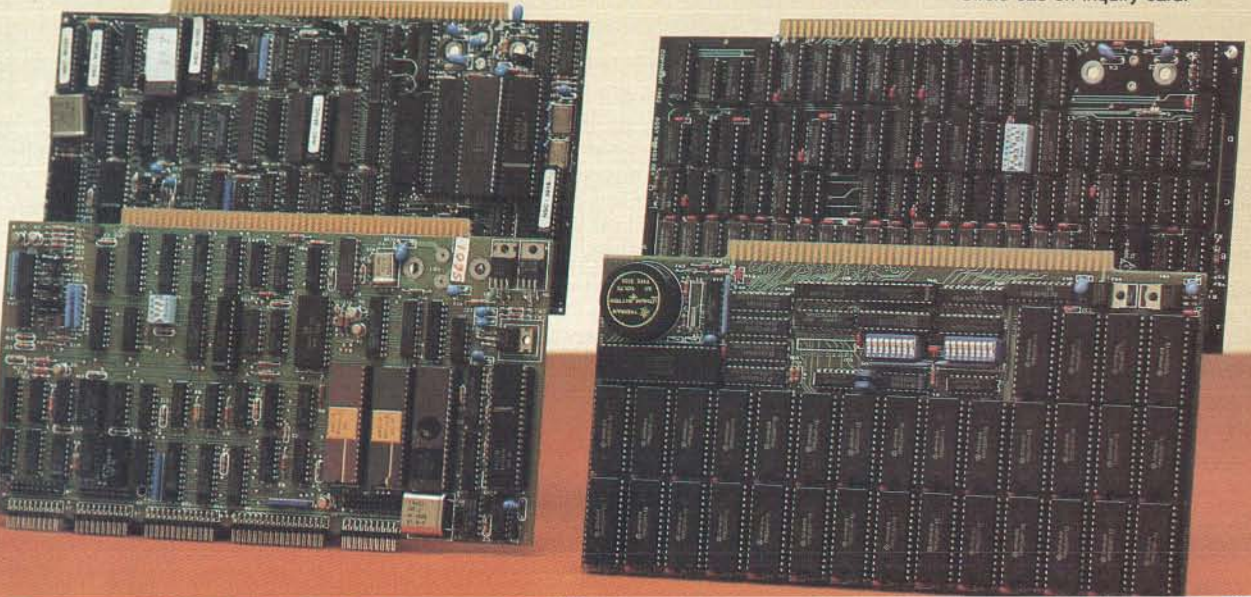

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Walt Disney and User-Oriented Software

Mickey Mouse teaches software designers a lesson

by Paul Heckel

> *When the outstanding violinist Isaac Stern was asked the difference between the great and the truly great, he replied, "The ability to communicate." It is the key ingredient in every art form and certainly the great strength of Walt Disney's genius.*
>
> —Frank Thomas and Ollie Johnson
> ***Disney Animation, the Illusion of Life***

Today we can look back on what Walt Disney did 50 years ago and learn a great deal about how to design friendly software. Disney created Donald Duck, Mickey Mouse, Goofy, and Pluto. He also created *Pinocchio*, *Bambi*, and *Fantasia*. Forty-five years after it was made, *Snow White and the Seven Dwarfs* was a box-office success this past summer. The Disney movies were a delight of our childhood; they still have the power to enchant us as adults.

Walt Disney used a new medium to develop a new art form (feature-length animated movies) and in the process rediscovered the principles of effective communication. Twenty years earlier, D. W. Griffith helped make film an art form with *Birth of a Nation*. Both Disney and Griffith seized a new technology; in so doing, each rediscovered, or at least reapplied, fundamentals of communication.

"What," I am sure you are asking, "does that have to do with computers and writing friendly software?"

Computer software is a new medium, and writing easy-to-use software consists of treating it as a communications task. Software designers can learn from professional communicators such as writers, filmmakers, advertisers, and salesmen by examining the techniques they use and applying these techniques to software development. Visicalc uses many of these principles, as does Wordstar, the Xerox Star, and Apple's Lisa.

My main objective in the book from which this article is taken is to identify these principles and offer examples from prose, film, advertising, and successful software such as Visicalc and Wordstar. Software writers can learn by studying the formative stages of a communication art form as well as the principles used in its mature stages. After all, we are in the formative stages of developing user-oriented software.

As I was finishing the manuscript for my book, I read *Disney Animation, the Illusion of Life* by Frank Thomas and Ollie Johnson (Abbeville Press, 1981). The authors, Disney studio animators from 1935 until they retired in 1978, wrote this book to record how the great Disney films were made. They describe the thought processes that go into creating an animated film, the atmosphere in which those great films (*Snow White*, *Fantasia*, *Bambi*, and others) were created, and much more.

For anyone seriously interested in designing user-oriented software, this book is must reading because it tells you how to think about communications. So much of what the authors say about creating animated cartoons is directly applicable to writing user-oriented software; a review of some of its high points serves to provide insights into what makes communication effective.

Disney Animation tells the story of the invention of an art form and the rediscovery of the principles of communication and theater. It is a constant iteration of those principles. Its authors, who are artists rather than

This article is taken from the book *The Elements of Friendly Software Design* by Paul Heckel, which is scheduled to be published by Warner Books in February 1984.

writers, show by the interest and excitement they arouse in the reader that they have mastered the principles of communication and that these principles are universal. It is worth reviewing here some of the fundamentals they discuss.

Make It Interesting

First and foremost, every scene and every sequence of a Disney film had to be interesting. A dull sequence would always be revised or eliminated and was never left in because it was needed for continuity. If in designing software we exerted one-tenth the effort that Disney did just to make his films interesting, our software would improve tenfold. (In an effort to avoid using repeatedly the awkward construction "Walt Disney and his artists," I use the word Disney throughout this article. When referring to Walt Disney specifically, I will use his first name.)

Disney storymen and animators constantly looked for "a piece of business" that would bring a character to life and make it interesting. A character never simply walked from one place to another: too dull. He might be angry and show it in the way he walks; he might drag something along; he might scratch his head. But he would do some piece of business that was in character, advanced the story, and was interesting.

The concept of a piece of business was new to me. Yet having software let you know that something is happening by displaying a piece of business is a good technique. It is far better than having the user stare at a blinking cursor and wonder whether his program is working or not. With Quickview Systems software you get a piece of business when a long message is displayed. Characters on the left side of the screen are deleted as new characters are brought in from the right side. This display technique is unusual and gives a certain personality to the software.

Exaggerate Reality

Early animators discovered that two related keys to making a character interesting are exaggeration and caricature. Reality must be the starting point: it is necessary to identify the essence of an animal or a person, and at Disney this was researched in great detail. Once the essence of a character was identified, it was caricatured and its movements were exaggerated. This made the character more interesting than the real one it was based on. Thomas and Johnson point out that this is true of all art. Michelangelo's David is not proportioned like a real human being, nor is Disney's Bambi proportioned like a real deer. Bambi may be deceptively similar to the deer we know, but it is designed so that the animator can exaggerate its actions and thus make it fascinating. (The most difficult characters to animate are human ones such as Snow White. The animators' dilemma is that an accurately drawn human character is difficult to make interesting, but the audience won't identify with a character that is a caricature.)

Software is a visual medium; we should resort to words as a last resort.

This, too, was a useful insight. It suggests that the software designer's objective should not be to *accurately* model something the user is familiar with. For example, Visicalc provides an exaggerated spreadsheet, 254 rows of 64 columns, while a normal spreadsheet is approximately 15 by 50. Similarly, automatic calculation is an exaggeration of something that is done on a real spreadsheet. In both these Visicalc examples, the spreadsheet is used as a starting point, and a basic aspect of it is exaggerated. This combination of familiarity and showmanship gives the product its value.

Think in Visual Terms

From the earliest stages of a Disney film, the story was presented visually through sketches. "Walt usually left out the dialogue until a sequence had been developed to the point where he could see just how little was really needed. If the idea could be communicated with an expression, an action or a sound effect, or with music, he would not use dialogue. The storyman had to think in visual terms first, and when he did write dialogue it had to tell something about the character and not be merely exposition," say Thomas and Johnson. The authors quote director Alfred Hitchcock with approval: "When we tell a story in cinema, we should resort to dialogue only when it is impossible to do otherwise."

Software also is a visual medium; authors should resort to words as a last resort. In designing user-oriented software, you start out with a blank screen to fill, just like a filmmaker. I think of filling it the same way—with pictures. Commands come later and then only to support the pictures.

Prepare the Audience

Walt Disney used several techniques to focus the audience's attention where he wanted it. These techniques seem particularly appropriate to friendly software design.

First, staging is considered carefully. How should a particular scene be shown? Should it be indoors or outdoors? What is in the background? Which characters should be in it? How should they be arranged? Should it be a frontal shot, a side shot, a down shot, or a moving shot? Should it be a long shot or a closeup? The major consideration in any part of a film is always what is the most effective way to communicate the desired image to an audience.

Software is staged, too. How should information be structured on the screen? I think it would be useful to think of software as consisting of a series of scenes, each of which needs to be staged appropriately. Much software staging is ill considered; the rest is unconsidered.

Walt Disney used an old theatrical principle—anticipation. Before an actor does something, he first telegraphs what he is about to do. Before a Disney character would jump, for example, he would first bend his knees in preparation. This readies the audience for what will happen so it is not taken completely by surprise. A related technique, slow in and slow out, is used when going from one pose (or extreme) to another. The

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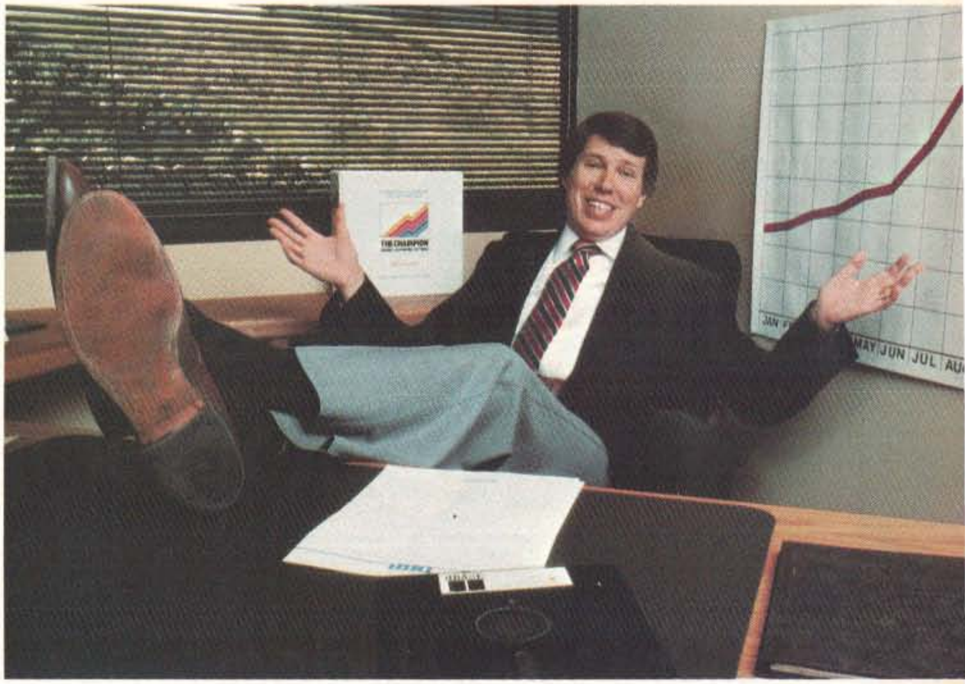

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character moves slowly at first, then speeds up, then slows down before settling into the next pose.

Any time a software designer wants to move the user's focus of attention from one place to another, a "slow out" can get the user to anticipate the general direction of the new focus. A "slow in" draws the user's eyes to the new focus of attention. For example, with Wordstar I sometimes use a FIND command to locate a particular text string and lose sight of the cursor on the screen. An inexperienced user would have more trouble. The slow-out/slow-in technique might reduce that problem.

Don't Crowd the Screen

Whenever more than one thing is on the movie screen, the audience usually gets confused. Walt Disney and his animators were always concerned about identifying the essence of what should be communicated in a scene and determining the minimum needed to say it. Every scene had to be communicated clearly. Backgrounds, for example, were designed so they didn't distract the audience from the action. Secondary actions in a scene always reinforced the primary action. Thus, for example, if the main action was a character picking a flower, other characters in the scene looked or pointed in the direction of the flower, focusing the audience's attention on the flower. Action was always staged so it was easy to see and not obscured by some other aspect of the scene.

A major problem with many computer screen displays is that they show too much. This indicates laziness on the program designer's part. Instead of finding what is important to the user and showing only that, he shows everything and expects the user to find what he needs. The user is often overwhelmed; what he needs is often not clear to him. This can be particularly serious for the new user and an annoying problem for the experienced user. Software must be simple, clear, and easy to understand.

Involve the Audience

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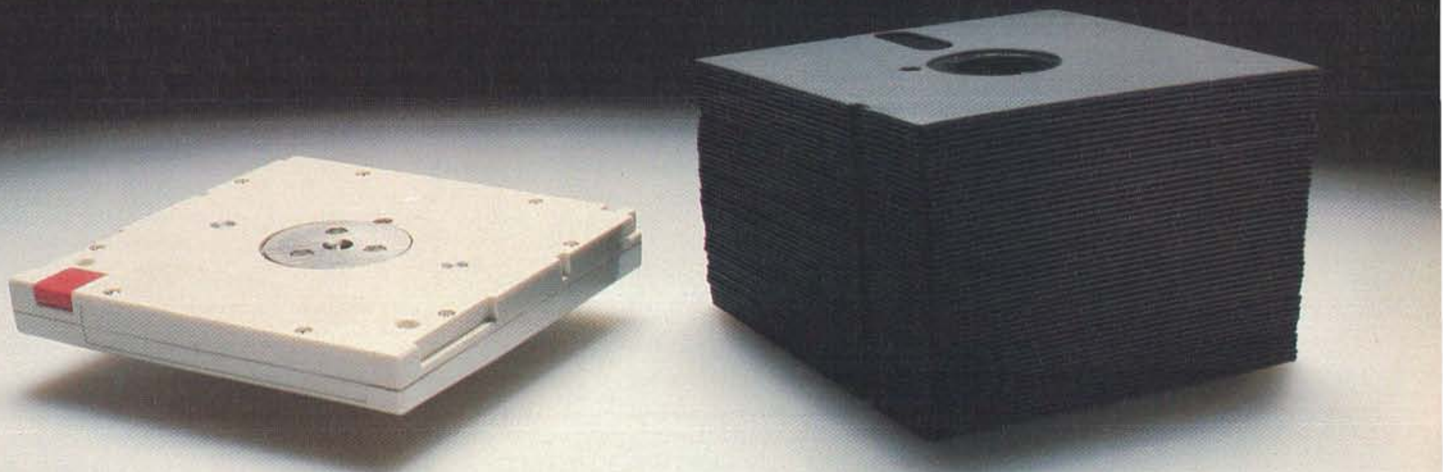

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Disney animators, Thomas and Johnson write. "We involve the audiences in our films. . . . We start with something they know and like. This can be either an idea or a character, as long as it is familiar and appealing. It can be a situation everyone has experienced. . . . But there must be something that is known and understood if the film is to achieve audience involvement."

Dave Hand, a Disney animation director, described his craft this way: "Our entire medium is transference of thought. The thought is created first in the mind of the storyman . . . then transferred to the director, who attempts to transfer it to the animator. . . . The animator then attempts to transfer it pictorially. He takes out the intangible and places it in tangible form, in picture, for transference back to the mind of the audience . . . and picture presentation is clearer than any other means of transferring thought from one person to another."

Software designers should use the same approach as Disney animators: involve the audience, start with something they know and like, and keep it familiar and appealing.

A Case in Point: Visicalc

Using an application program also involves the transference of thought. The software designer starts out with an idea of what a program must do. But for the program to be effective, the designer must transfer to the user the concept of what the application program can do. Visicalc serves as an excellent example. The designers, Bob Frankston and Dan Bricklin, had an idea for a new type of electronic spreadsheet. But to be successful it had to make sense to the program's potential users. Several techniques were employed to accomplish this task. First, the authors used a window to display only part of the spreadsheet on the screen. Second, the user can examine different parts of the spreadsheet by moving the cursor, much the same as a movie camera pans a scene too large to be taken in one static shot. Third, the designers selected formulas (e.g., SUM) and user commands (e.g., REPLICATE) that implemented operations similar to those done on paper spreadsheets. These techniques reinforce in the user's mind the image of a large spreadsheet.

The Animation Development Process

Disney's early animated shorts took only a few months to make. It was only after Walt improved his techniques of animated filmmaking and tackled full-length feature movies that the importance of planning and research became apparent. A typical Disney feature film took three and a half years to make: six months of research; one year of work on the story, styling, and experimenting; one and a half years of animation; and six months of follow-up to add color and music and photograph the 460,000 drawings that made a finished film. The making of a Disney movie was a constant process of prototyping, revising, and rewriting. The organization and the development

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process were designed to facilitate this operation.

Throughout the development stage, everyone got to see a more and more complete version of the final film; they could relate what they had done to the whole and better see what needed revision. They could see what worked and what didn't work. Woolie Reitherman, a Disney animator, explained, "Many ideas that sounded great in those story meetings become sodden and lifeless when seen on the screen in relation to the rest of the business, and the sooner these elements can be discovered the sooner they can be corrected. Many other story ideas that were only 'touches' will come to life in animation with so much entertainment that it is foolish not to get the full value from them, even if it means adding considerable footage.''

This is not an entirely smooth process; it is not supposed to be. Its purpose is to bring out what works and what doesn't work, the problems and the pleasant surprises, and to do it as early as possible. For example, if a particular animation sequence runs longer than the music scored for it, the composer might add another half-measure. If a particular sequence does not work as expected, it has to be redone or abandoned.

The Software Development Process

Program designers, like Disney animators, have had to improve their technique for producing personal-computer software. When microcomputers first became popular, the early applications programs were relatively simple and required only a few months to write. But contemporary software such as Wordstar or Visicalc required more than a year's effort to produce. This trend has continued; Visi On and the newest software for the Lisa computer required a dozen or more programmers working for two to three years. With software becoming more sophisticated and users becoming more demanding, the development process will continue to take more time and effort.

Much of the best software has developed as a result of evolution. Many programs originate as a prototype to test the practicality of an idea. Visicalc was first prototyped in a BASIC program before it was developed into a consumer product. Some software is an improved version of an earlier product. Wordstar, for example, is based on the earlier Wordpro word-processing package.

In developing software at Quickview Systems, we start out with a primitive version of the product, similar to story sketches for a Disney film. We repeatedly test and modify the program to see how it "plays" in both formal and informal testing. We see what works and what doesn't and change the software to best reflect what we think it should do. This procedure allows our rough prototype to change into a final polished product.

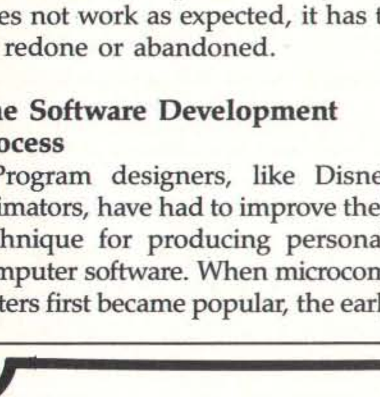
Make the Best Guess

Disney created a set of tools that helped make films, just as software companies have developed a great many tools to help make software. Some of Disney's tools were designed to ensure a quality product; studio management tools were designed to keep track of progress and ensure that all the details merged together correctly. But the main purpose of these tools was to enable studio workers to make a "best guess" of what the audience's experience would be. Everyone could quickly adjust his work to the reality and see the results of the adjustment. To develop quality software, designers need a similar environment that will give them the best guess of what the audience's experience will be.

Try Again

The final lesson that Walt Disney can teach us may be the most important. Hemingway, Frank Lloyd Wright, Beethoven, and Picasso couldn't get things right the first time. Walt Disney couldn't, either. And no software designer can get the user interface right the first time. But by carefully analyzing what the user needs and following the precepts that Walt Disney rediscovered, you can raise your software designing to a commercial art.■

Paul Heckel is the founder and president of Quickview Systems (146 Main St., Suite 404, Los Altos, CA 94022), which develops software products for notebook and other small-screen computers. He has designed several user-oriented products, including the Craig M-100 Language Translator. He has 20 years' experience in developing software and holds a B.S. degree in electrical engineering from MIT and an M.B.A. from Stanford University.



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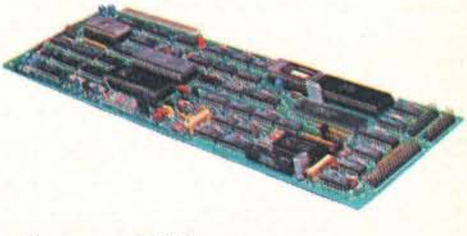

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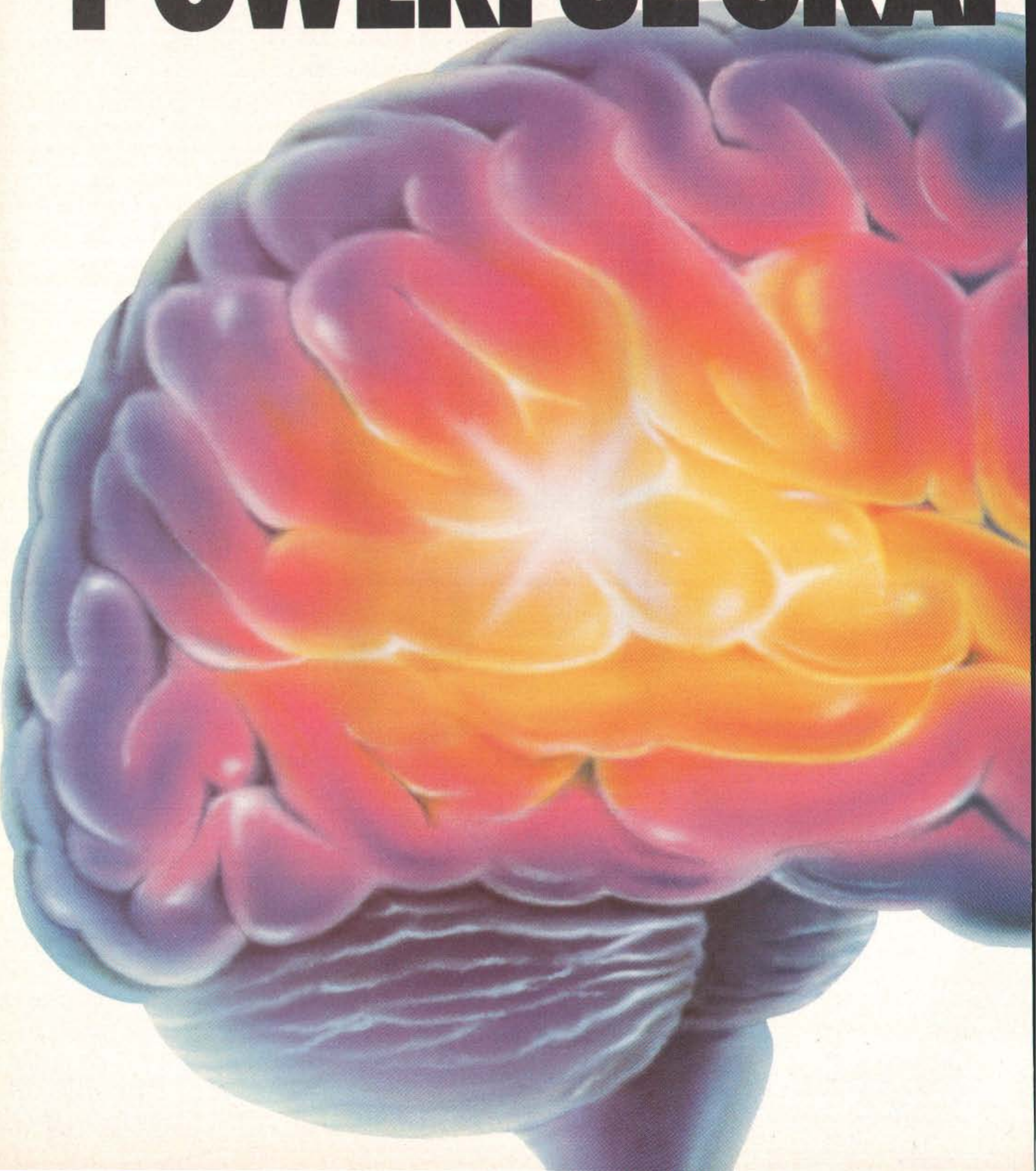

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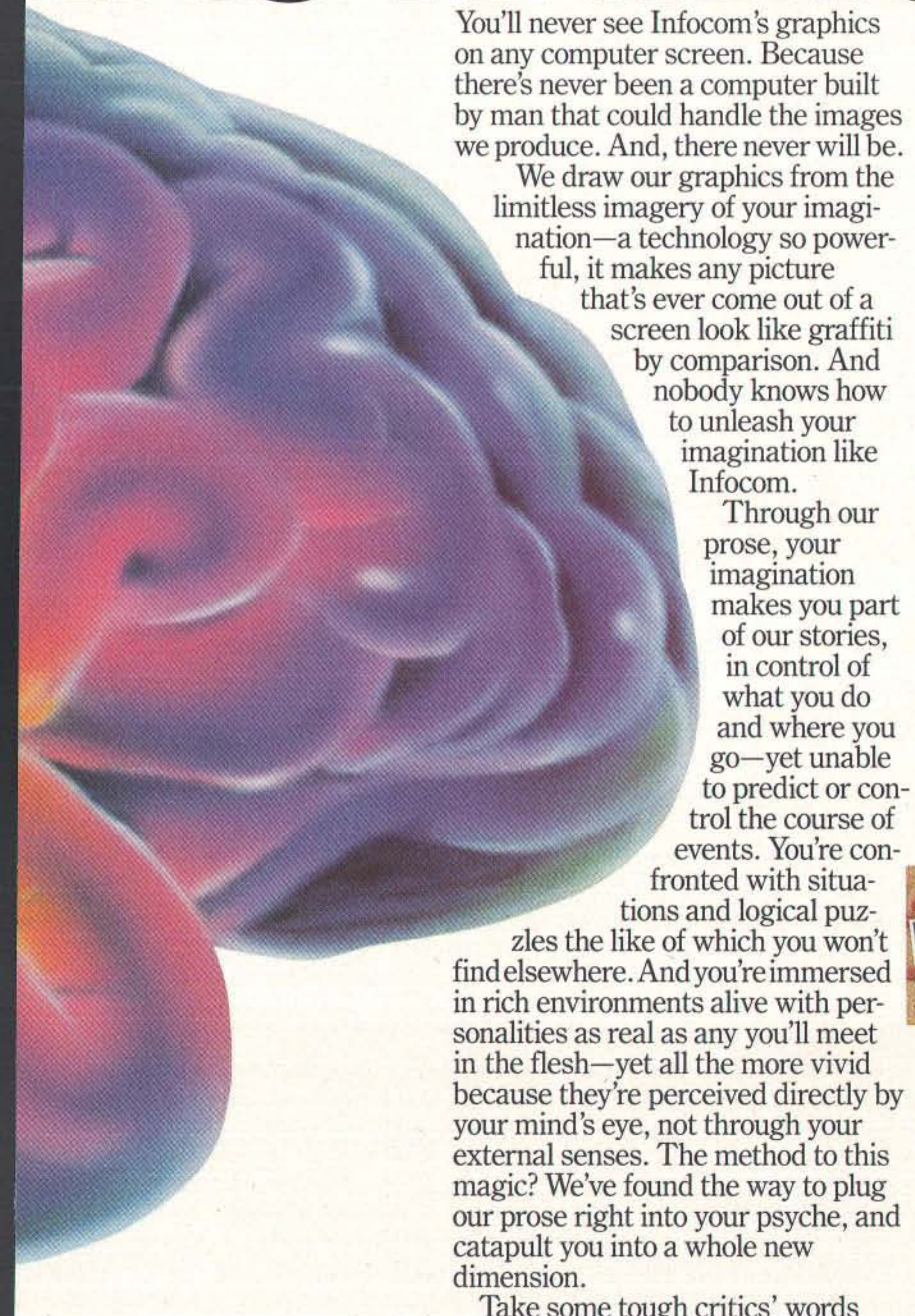

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Making Life Easier for Professional and Novice Programmers

A visual programming technique simplifies program development

by Andy Pope, Geoff Kates, and Dan Fineberg

When the first microcomputers appeared on the market, most programmers coded their applications in assembly language because of limited memory (less than 64K bytes) and the need to optimize code for speed of execution. The first debugging programs, designed for assembly-language programs, came from semiconductor and operating-system vendors. These products let programmers single-step through a program, set software breakpoints, display and alter central-processor registers and system memory, and regain control of a system after an error caused by a program.

The next level of debugging included the ability to symbolically debug a program. Programmers no longer had to set breakpoints at machine addresses; breakpoints could be set at either a particular line in the program or at a particular name in the program. In addition, conditional breakpoints became more widespread, meaning that a program could be stopped when a condition was met, such as when a variable equaled a certain value.

Writing programs in assembly language was fine in the 8-bit world when only a limited number of microprocessors (e.g., the 6502 and the Z80) and operating systems (e.g., Apple DOS and CP/M) were prevalent. But the arrival of 16-bit microcomputers made the use of existing high-level languages more attractive for several reasons. First, 16-bit microcomputers run faster and have less severe memory constraints. Second, a greater variety of microprocessors (the 8086, Z8000, 68000, and 16032) and operating systems (CP/M-86, MS-DOS, Unix, Oasis, etc.) make the transfer of software among different machines virtually impossible in assembly language but relatively simple in high-level languages. The latest trend shows C to be the language of choice for systems software (because it is closest to assembly language); C and Pascal for word processors, spreadsheets, and database-management systems; and COBOL for the vast majority of business applications (see "Why COBOL for Business Application Development?" on page 158).

As computer users and programmers rely more on screen icons, menus, and color graphics, they will be using their minds in a different way.

The next logical step moved the debuggers from operating at the assembly-level language source level to debugging at the high-level language source level. The first such products simply took the various assembly-level capabilities and transferred them to the high-level languages. Although a great improvement, these products did not provide the necessary user interface for a truly productive program-development environment.

Visual Programming Tools to Improve Productivity

We studied the features needed to make debugging tools more user-friendly and productive. With the previous debuggers, only two ways existed to trace the flow of a program. The single-step method proves to be laborious with a large program. The second method sets breakpoints, creating a problem because a programmer knows only that the program has reached a defined point from a previously defined point; the interim remains a mystery.

Another important debugging issue was developing a "what-if" capability to enable programmers to simulate various scenarios. Other critical areas were the screen-handling capability and more flexible breakpoint handling.

Visual Programming

So far, the quest for more effective

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To help increase programmer productivity and reduce the toil involved in writing and debugging a COBOL program, Micro Focus has developed a variety of visual programming utilities. The Animator program solves COBOL debugging problems in a flexible manner. Animator lets a user actually watch a program execute on the screen. As each statement executes, the cursor moves to the next statement. A user can watch the flow of the program as it is executed or "animated." Nine different execution speeds are available, and the speed can be set before the program is animated or altered during the animation. This animation is stopped either by a command or when a breakpoint is reached. Normal full-speed execution is allowed. In addition, another command allows execution until an IF statement is reached, allowing the user to do what-if experiments when the program branches.

Another desirable feature for program debugging is flexible screen-handling. Too many debuggers let the user scroll up and down the screen only one line at a time. Animator is very flexible in this area. Screens can be scrolled up or down for either a partial or complete screen at a time. In addition, the user can jump to the start or end of a file with a single command.

One of the nicest features supported is split-screen operation. Two independent areas of the program can be worked on at the same time. Only the area where the cursor is positioned is "active." In addition, either window can be enlarged at the expense of the other.

It is sometimes necessary in debugging a program to find a variable in the source code and then monitor it as a program is running. Rather than search through the code line by line trying to locate the particular variable, Animator lets the programmer use a FIND command to locate the variable. Once the variable has been found, it can be monitored during animation, so after each line has been executed the new value of the variable is displayed.

Once the problem has been found, code normally has to be changed. In most other environments, the user has to go back to the original source code, alter it, and recompile it in order to try out the patch. To save this effort, Animator allows the user to instantly compile and execute one or more lines of text. The programmer can check out his patch before altering the source code.

Other Visual Programming Tools

Advances in interactive, screen-oriented programming tools have been concentrated in the world of mini- and microcomputer-based COBOL development. One reason for this is that COBOL is popular in both the data-processing world and the microcomputer world, and these two segments are converging because of the FORTUNE 1000 sales success of microcomputer manufacturers such as IBM, Apple, DEC, and others. COBOL is popular for large and small business-application development because of its strengths for applications that are I/O (input/output) intensive and require heavy data manipulation.

With COBOL, a great deal of time can be spent defining screen input and output. This is a laborious task that can be automated with a forms generator. A forms generator enables programmers to enter the input and output screens they want directly onto the screen. It will produce the COBOL source code required to make the interactive screens functional.

Micro Focus's FORMS-2 is one example of an advanced forms generator. It is menu driven and easy to use. Experience has shown that even nonprogrammers can produce screens after only a few minutes with it. Once FORMS-2 has created a COBOL source file, the file can be incorporated into an application program by using the COBOL COPY command.

and friendly user interfaces has concentrated on developing new ways for the computer user and the programmer to interact with the system via the screen. The desktop metaphor, mouse, windows, and icons in Apple's Lisa computer provide an excellent example of this emphasis on interactive visual devices.

As computer users and programmers rely more on screen icons, menus, and color graphics, they will be using their minds in a different way. Previously, programming emphasized calculation, codes, and mathematical or verbal symbols. According to current medical theory, computers require people to use the left side of their brains more than they normally do in everyday situations. The left hemisphere is, it is thought, the brain's center of language, calculation, and analytical thinking. It works with logic, reason, and the methodologies of computer science.

The right hemisphere is thought to be the visual side of the brain. It is active in visual comprehension, spatial construction, and nonverbal ideas. It works with intuitive thought and artistic creativity.

Recent advances in human interfaces to computers have worked to balance the use of both hemispheres. As a result, we can more intuitively understand and use a computer system and creatively apply artistic concepts through computers.

Interactive use of computers via visual devices not only makes computers more accessible to users but can make programming more productive as well. We'll define productivity as a function of effectiveness, efficiency, and quality. In turn, effectiveness is the ability to meet objectives, efficiency is how much output results from how much input, and quality is the level of satisfaction gained from the product by the customer.

Software tools to make programming more visual can increase a programmer's effectiveness by enabling him to meet more programming objectives. For example, a programmer may use a source-code generator that lets him "paint" interactive screen formats directly onto the screen with the keyboard (see "Micro Focus Programming Tools" on this page). He can automatically create interactive screen-handling programs and develop a more interactive application package. For example, a payroll application can include more interactive input screens and menus for data entry because the displays take less time to create.

Visual programming tools increase a programmer's efficiency by enabling him to get more done in less time or at a lower cost. A debugger that "animates" the program's source code on the screen and lets the programmer engage in what-if analysis

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Why COBOL for Business Application Development?

In May 1959, a group of computer users and manufacturers met at the Pentagon. They expressed the aim to design a "common business-oriented language (COBOL) independent of any make or model of computer, open-ended and stated both in an English and a narrative form."

This group grew into the Committee on Data Systems Languages (CODASYL), *the guiding force behind the evolution of the COBOL language. The first version of COBOL appeared seven months later in January 1960. Now, almost 24 years later, there is more than $100 billion invested in COBOL applications worldwide.*

COBOL, the Business-Oriented Language

For a typical business application such as a general ledger, a programming language is needed that offers the ability to organize and handle large amounts of data and the facility to manipulate this data. For example, a business application developer needs to be able to add, subtract, multiply, and divide, and he also needs the facility to produce reports and printouts in an easy, efficient manner. He does not need the facility to handle matrices and complex mathematical functions as in a scientific application.

These needs have been addressed by COBOL in several ways. First, approximately half of the language is dedicated to methods of file-handling. For example, a data-file can be accessed as a sequential file (one record following on from the previous one); an indexed sequential file (data can be accessed according to a key field that is contained in each record); or a relative file (a data record can be referenced according to its position in the file). Second, a sort module permits the reorganization of data files according to complex user-defined parameters. Third, COBOL provides simple commands such as ADD, SUBTRACT, MULTIPLY, and DIVIDE.

In addition to these basic features, COBOL offers an easy self-documenting format. A COBOL program looks like English composition, with paragraphs, sentences, verbs, and the ability to use easy-to-understand data names such as TAX REBATE, ACCOUNTING PERIOD, NET PROFIT, and so on. Superimposed upon this is a "dictionary" called the DATA DIVISION that relates the data names to memory locations within the computer.

These features mean COBOL application developers benefit by being able to create programs that are easily understood and can be read by nonscientific computer users, and the applications can provide an easier-to-use human interface.

COBOL Is Standard and Portable

COBOL evolved from the first meeting of the CODASYL committee. The committee still meets six times a year for four days at a time. The CODASYL committee currently has 23 members, which comprises 12 implementors (compiler writers and major mainframe manufacturers) and 11 users. The CODASYL committee produces the COBOL Journal of Development *(JOD), which is regularly updated and republished every two to three years.*

Periodically, the American National Standards Institute (ANSI), through the COBOL committee (XJ34), produces a new standard version of the language. This standard was first published in 1968 (ANSI '68 COBOL) and then updated in 1974 (ANSI '74 COBOL). The ANSI standard is derived by examining the current standard and the latest CODASYL JOD and then including new features and removing some old features. The ANSI Committee itself cannot propose features.

ANSI COBOL consists of 12 modules. They are: NUCLEUS, TABLE-HANDLING, SEQUENTIAL I/O, RELATIVE I/O, INDEXED I/O, SORT-MERGE, REPORT-WRITER, SEGMENTATION, LIBRARY, DEBUG, INTER-PROGRAM COMMUNICATION, and COMMUNICATIONS.

Each of these modules, except for

to find logic errors can drastically reduce debugging time. More programs can then be written and stabilized in a given period, and that in turn reduces the cost of program maintenance, the most expensive aspect of large business-application programs.

In addition, programmer satisfaction increases because visual programming removes the laborious elements of application development and enables the programmer to spend more time developing creative solutions to application problems.

Programmers can also operate more intuitively. For example, the what-if analysis that is allowed by the animation technique lets programmers test alternatives freely without the risk of having to rewrite entire blocks of code.

Greater use of intuition and creative problem-solving means programming can be more fun and less alienating. With the current shortage of programmers, visual programming can increase program production by improving individual programmer productivity and by attracting more people to programming.

The Animation Technique

The animation technique, developed by Micro Focus for in-house programming, is now available in product form for programmers who use Micro Focus COBOL compilers. It makes programming easier the way a stethoscope makes medical diagnosis easier. The doctor's tool enables him to listen to the heart of a patient and, in turn, use his medical training and expertise to trace symptoms to find the cause of an illness. The animation technique lets the experienced programmer trace the effects of an error through a new or old COBOL program's logic and data structure.

A typical example is the 10-year-old payroll package that has been working fine week after week but suddenly pays an employee a negative amount. The programmer who wrote the program has long since left the company, and the data-processing staff has to find the very subtle anomaly in the program logic that caused the negative payment. Without a debugging tool such as Animator, the process would be done in one of two ways: the data-processing department would obtain a source-code listing and trace through it, trying to reproduce the error; or a DISPLAY statement and some debugging logic (e.g., IF <error condition> STOP RUN) would be inserted

REPORT WRITER, has been split into two subsets, the LEVEL I specification and the full LEVEL II specification. The minimum ANSI standard COBOL compiler consists of a LEVEL I specification for the NUCLEUS, TABLE-HANDLING, and SEQUENTIAL I/O.

Superimposed upon ANSI standard COBOL is a further standard that has been developed to meet the needs of the U.S. Government. It is called Federal Standard COBOL. The Federal Standard designates four ANSI COBOL levels of implementation: Low, Low-Intermediate, High-Intermediate, and High.

Furthermore, the Federal Computer Testing Center (FCTC), which is part of the U.S. Government General Services Administration (GSA), tests each COBOL compiler for compliance with the Federal COBOL standard. It does this by using a suite of programs comprising 225,000 lines and 5500 individual tests to check (and break, if possible) COBOL compilers. A compiler is tested at the implementor's claimed level and then placed on the Certified Compiler List either "with errors" or "with zero errors." For example, Micro Focus's LEVEL II COBOL compilers are GSA certified at the High Level with zero errors. The certification is valid for one year, then the compiler must be retested.

The result of these standards is that COBOL source code is portable across different machines, operating systems, and even different implementations of a COBOL compiler.

A New ANSI Standard for COBOL

The ANSI COBOL Committee (X3J4) has prepared amendments to the COBOL language that are to be incorporated in a new ANSI standard. The new standard, while it clarifies many ambiguities and makes the language more structured, does not address interactive screen-handling or record-locking facilities.

The addition of nonstandard interactive screen-handling facilities, such as those used by Animator, is vital in microcomputer-based COBOL compilers because micros are more personal and interactive in nature than the larger, number-crunching mainframe machines.

Nonstandard record-locking facilities have also been developed to protect users from simultaneous record updates in multiuser microcomputer environments. An example of such a record-locking facility is Micro Focus's FILESHARE for MP/M-family and TurboDOS-based systems.

Until the ANSI standard addresses these facilities, implementors will have to continue developing nonstandard screen-handling and record-locking additions to COBOL or agree on de facto standards to meet the needs of the emerging corporate microcomputer marketplace.

The current ANSI approach is to include in COBOL new program constructs and statements as well as rules governing nested programs.

New constructs include conditional statement terminators such as END-IF, a null statement called CONTINUE, a case-type multibranch statement called EVALUATE, an in-line looping construct called PERFORM that now includes END-PERFORM, and a "test after looping" construct.

Another significant change is a new INITIALIZE statement that is used to initialize an entire record or any type of data item to specified values. In addition, the new standard lets programmers MOVE data from an edited data item to an unedited one. Finally, the standard permits a new way of specifying the length of variable records. Each such record length can be stored in the name of the WORKING STORAGE data-item that is specified in the FILE DESCRIPTION ENTRY. Programmers will be able to read a record and rewrite it with a different length for indexed or relative files as well as SORT and MERGE variable-length records.

in the source code and the program then recompiled and run. The second method results in the computer displaying "snapshots" of the data at the points where DISPLAY statements were inserted. The programmer can then look through "windows" in the program to gain a better understanding (still using the printed listing) of what the program is doing.

With Animator, the situation is completely different. Programmers can not only set breakpoints to zero in on error conditions but can step through any portion of the source code, look at the data, modify the data, and go through the code again, thus engaging in "what-if" analysis as they go back and forth between the logic and the data.

Programmers can "zoom" through part of the program at near-normal execution speed, then step through the source code line by line at any position in the program that they choose. This is done at any speed required to allow programmers to follow and understand the program logic.

Animator lets programmers interact with a COBOL program in a way that is not otherwise possible. It enables them to select the parts of a program to look at, choose how often they will look at them, choose what data to use to demonstrate the code being looked at, and control the speed at which the code will run.

A programmer using Animator can examine different blocks of the program to diagnose an error. He can chase the symptoms through the different areas of the program until he locates the error, without having to run the program over and over again.

Making Programming More Fun

The animation technique takes the routine debugging burden off programmers so they can devote their time to more creative tasks such as new-program development. And by cutting their backlog, programmers have more time to write better, higher-quality programs.

The animation technique eliminates the drudgery of debugging by making the computer do the computing tasks that programmers had previously done. Before the animation technique, programmers who were debugging programs had to simulate the operation of a computer in their minds.

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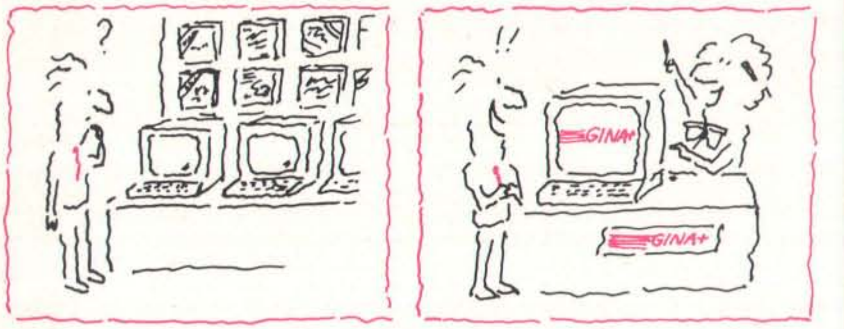

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how blocks of code are related. Thus, programmers can understand the overall flow of the program. They can find out what the blocks are, what they do, and how they are linked together simply by tracing the program execution through the source code. By seeing the structure of a program, programmers can find where an error will show up once they have seen the symptoms.

To learn a COBOL program in more detail, programmers can use the Animator trace functions and engage in "what-if" analysis within the program blocks. This means programmers can, if need be, gain an expert understanding of the precise consequences of any data value change and its implications in each module of the program. They can watch the logic flow step by step and switch back and forth between the code and the data to see the precise relationship between individual source-code statements and incremental changes in the data structure.

A Concrete Programming Environment

The animation technique turns analysis of programs into a concrete process. Without animation, analysis is an abstract process because the programmer has to assume how the logic *should* operate. Using the abstract process, the novice may overlook a subtle yet catastrophic detail in the logic.

Animator makes program analysis concrete by enabling programmers to see the occurrence of the catastrophe right before their eyes, on the screen. Animation shows what the program says and does, not what programmers hope or think the program says. With concrete information on what their programs are doing, programmers can test various alternatives and choose the best logic routines for their applications, with zero errors.■

Andy Pope, technical specialist, Geoff Kates, product marketing manager, and Dan Fineberg, marketing communications manager, are part of Micro Focus Inc. (2465 East Bayshore Rd., Suite 400, Palo Alto, CA 94303), an international supplier of microcomputer software for business-application development.

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Simplify, Simplify, Simplify

A logical program design, not fancy technology, makes software more useful

by Martin Dean

I have never yet seen an article in a computer magazine that could tell me how to design software. As a matter of fact, I have never seen an article anywhere that details the mysteries of software design. I've even wondered if it was a plot to deny users the inside information about how the software that we used was created. Surely there ought to be an article where the author says, "I had this problem, and I used this design philosophy to make a piece of software to solve the problem in the simplest, most direct way."

This is that kind of article.

Background

When I first discovered software, I was amazed that so many people knew BASIC. Four or five years ago, only two kinds of software design existed. The first (the kind that most of us learn first) is called basic BASIC. Because of BASIC's simple input and print statements, the design structure of a program can be rather simple and uncomplicated: input the information into the program, and print the information out when it has been processed or organized. For example, if you want to calculate the distance from A to B, you ask: "What is the rate of speed?" and "What is the time it took to travel the distance?" Then you would put the values into variables named R and T. The BASIC programmer simply needs to say "D = R*T" and "PRINT D", and the answer appears on the screen.

Enter the more advanced programmer, conversant with machine language, C, FORTRAN, 8080 assembly language, cross-assembly language, and DIBOL. Now the distance program becomes more sophisticated. "Enter here the rate of speed traveled in the interval, as an average, in miles per hour," and "Enter here the period expressed in minutes and seconds that it took to travel the distance as described in the distance D." And then things became complicated. And, of course, when things became complicated, the programmers had an answer for those less fortunate: an innovation called "extensive documentation." They gave us eloquent definitions such as "a list is a set of values assigned to positional element numbers." Oh! Often 400 pages of documentation described what the rest of American industry could explain in 8.

When it became clear that programmers couldn't solve their own problems, hardware manufacturers got into the act. Now we have mice and windows to make our computer lives easier and more user-friendly.

Let me state my opinion of this as clearly as possible: it's all nonsense.

First, computer software design got the wrong start when we, in our awe of programmers, let them get away with murder: murder of the English language, murder of common sense, and surely murder of the concept "easy to use."

Then we let the programmers design the software. This may sound obvious, but it isn't. Sure, programmers write the code that makes the computer work, but that doesn't give them the right to design how information goes in and how it comes out.

Imagine for a moment that we let experts in instructional technology or people with a sense of discipline and common sense design what is called

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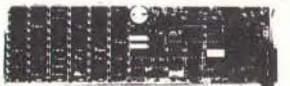

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"the front end," that portion of the software that bridges the gap between the computer program itself and our eyes, brains, and fingers. Imagine what software would be like if we didn't ever have to read messages like "Do you want the seventh bit to be a stop bit . . . yes or no?" Imagine messages in real English, organized in a fashion that has real meaning for those of us who use them.

An Alternative

I was several months into the design of a database manager for my company before I realized what a strange turn the direction of software design had taken. There was no literature that described the fundamentals of microcomputer software design, and theorists were still postulating the discoveries of Piaget and Vygotsky as reliable beginning points for software design. What had become the established norm for good software design was not good software but simply software that sold. As recently as the fall of 1982, microcomputer software entering the marketplace was distinguished by fatter manuals, more commands, and a complexity approaching unusability.

Thus, I concluded that even before I could attack the particular problem that I had been given, I had to go back and look at the history of software screen design and then take a whole new approach to it. The result was amazing. Three words were the key to my design—simplify, simplify, simplify.

To do that, radical emotional surgery is required. You have to throw out your admiration for other software programs, clear your mind of brilliantly executed screens, disregard nifty features, and excise all thoughts of clever though complex functions. Pledge yourself instead to starting fresh. Think only of the first-time user, the scared, irritable novice who for the first time must not only work with a computer but do something useful with it.

Today's user is so different from yesterday's pioneer that the design criteria once applied are now totally inappropriate. Today's user is no

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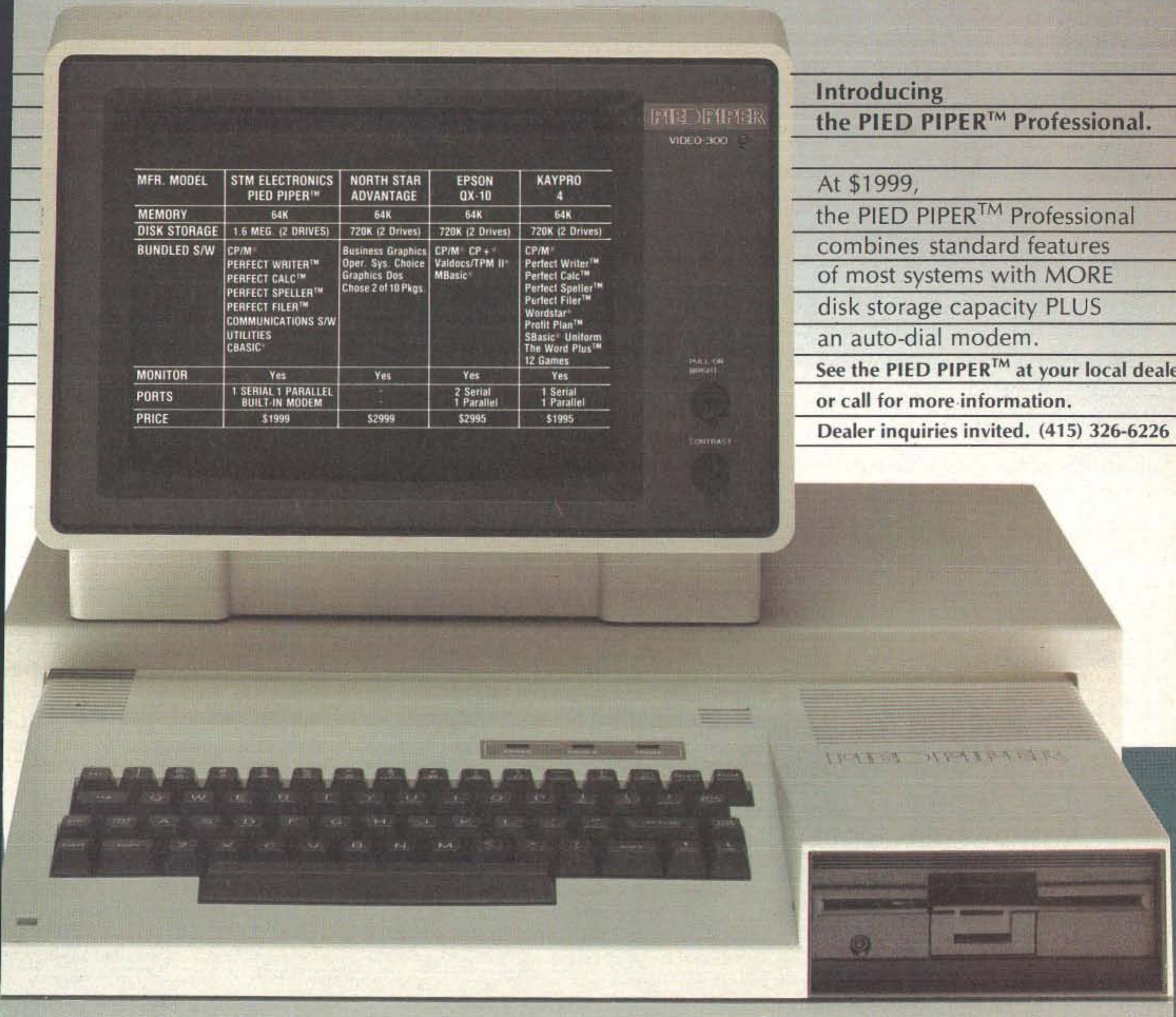

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longer the engineering-oriented hobbyist. Nor is he the adventurous, chance-taking, first-one-on-the-block user. All of these pioneers have already bought their computers and programs; now the field is left to those of us who waited for $200 calculators to cost $20.

Command-driven vs. Menu-driven Software

The first design idea I had to throw out was the way that choices are presented to the user, so I focused on the difference between command-driven and menu-driven software. Traditionally, command-driven software is identified by the appearance of a dot or a prompt on the screen and little else. This type of software is rich with hundreds of commands that are usually invoked by pressing the Control key and a series of additional alphabetic or numeric characters. Software of this family is advertised as being "complete, full of features, and *very powerful.*"

But there's a problem with this method. Imagine walking into your favorite gourmet restaurant one evening and having the chef come to your table and say, "Good news, we have changed the way that you order food. Now you can have anything that you want. Just tell me what you want and I'll make it for you." And there you sit, trying to remember what sort of sauce the veal came with last time and whether it was pepper or peppercorns that you liked in your green beans. Imagine a command-driven restaurant. Then mourn for it when it fails because no one knows what to order. The same is true with software. Users don't want to be able to order anything that they can imagine. They don't, in the main, even want to imagine. They only want to get a job done. Open-ended, command-driven software is dead.

On the other hand, menu-driven software is just what it says. The screen offers a choice of things that you can do and asks you to enter a number or a letter corresponding to your choice.

So I decided to have menus. Where should I go from there?

I then looked at what I had to make and how it had been made in the past. In this case, I had to create a relational database that could be used by first-time businesspeople to produce something useful, a program that was obviously worth the money they paid the first time that they used it. To do this, I knew I would have to change entirely the way that data is perceived, stored, and retrieved, so that it would more closely resemble the way that you and I store and retrieve information in our offices.

The Traditional Database

This is how it used to work: first, the program starts with a totally blank screen onto which you are allowed to design the form that would be filled in to create a record. Now, of course, to be able to design this form, you must designate the fields you want, what length those fields will be, what type of data will be in those fields, and so on. It leaves the beginner paralyzed because, like command-driven software, it offers too many open-ended choices. Once

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Col→ Row ↓	A First Name Text = 20	B Last Name Text = 15	C Area Code Number	D Telephone Text = 20
1	Albert	Finney	212	345-9754
2	Bobby Sue	Jones	211	556-9088
3	Tom	Wilson	312	678-9073
4	Jeannette	Donner	313	567-9234

Table 1: *An on-screen chart for data entry. If the contents of a field are greater than the chosen column width, the entry wraps around to display the entire contents.*

Column→ Compare ↓	First Name	Last Name	Area Code	Telephone
=			312	
not =		W*		
LTE <=				
GTE >=				
LT <				
GT >				

Table 2: *A "test chart" that replaces Boolean logic in selecting records from a database. Given the convention that * matches any string of characters, this chart asks for all records with an area code of 312 and with a last name that doesn't begin with W.*

you have designed your form, you must enter the information into it, just as you would for a job application or an insurance policy.

But you're not done yet. Now that you've got the information, how do you get it organized and out? The organization of data is what differentiates the computer from a card file. Computers are best at sorting out all your friends who have the same telephone prefix you do or birthdays in May. Unfortunately, when the programmers designed the way you ask the computer for information, they chose to stick with the same Boolean logic they used to write their programs. Now for those of us who took symbolic logic in college, Boolean algebra is just a replay of old headaches. For those who didn't, forget it—truth tables, logical separators, and exclusive ORs are not what you want to spend your time figuring out.

An Alternative Database

Four and a half months later, it dawned on me that there was absolutely no reason to retain any semblance of the rules that had been designed by database creators. With that in mind, I stood for many days at a large blackboard, trying to get to the root of what a database is, how it is perceived, and how it can be used. I finally derived from those sessions an intuitive breakdown of the basic database functions. First, I needed a new way to set up the format for storing information. This meant that I had to eliminate the requirement that the user understand the concepts of fields, records, and (of course) delimiters.

Before becoming involved with computers, I reasoned, I had stored information and had shown it to others without even knowing what a database was. Ever since I was a sophomore in high school and compared the economic, political, religious, and agricultural aspects of communism, socialism, and democracy, I had used charts. Why not use them now?

At the same time, why not make the definition of a data field as automatic as selecting choices from a menu?

The design I came up with is shown in table 1. Across the top are three rows of information. The top row simply labels the columns A, B, C, and D. The next row is the description of the columns, which programmers call the field descriptors. The third row tells the program what type of information it should be expecting. Rather than adopt the standards once again, I chose to use more meaningful descriptors such as Date, $, Number, Text, and Math (which is computed automatically when you enter a formula).

From there on the design of the chart was just plain puzzle-solving fun. How wide should the columns of the chart be? Should they be variable in width? Well, let's look at the charts I had made before I discovered computers. When there was too much text, what did I do? I started over with a new chart. Unfortunately, that wouldn't work here.

The main problem I had with my chart idea involved entering text. I wanted to make each field a "memo pad" area that could contain messages of widely varying lengths, and I wanted to display the whole field. Well, if I did that I could end up with a chart that was much wider than the screen. From word processing, I borrowed the idea of wrapping text onto multiple lines. From that, I conceived the notion that the user should be able to define both the number of characters that go into a field and the field's display width on the screen. If a given field is wider than its display area, its text "wraps around" and takes as many lines as is needed to display the entire field.

I decided that money, numbers, dates (in six different formats), times (in two different formats), and text would make up the choices of data styles. Then my mind hung up on the word "data." I had overheard this marvelous phrase: "data you store, information you use." I made a conscious decision then that I would never again refer to what was being stored as *data* but would use the term *information* instead.

Dealing with Logic

Now I had to solve the problem of how to sort information without re-

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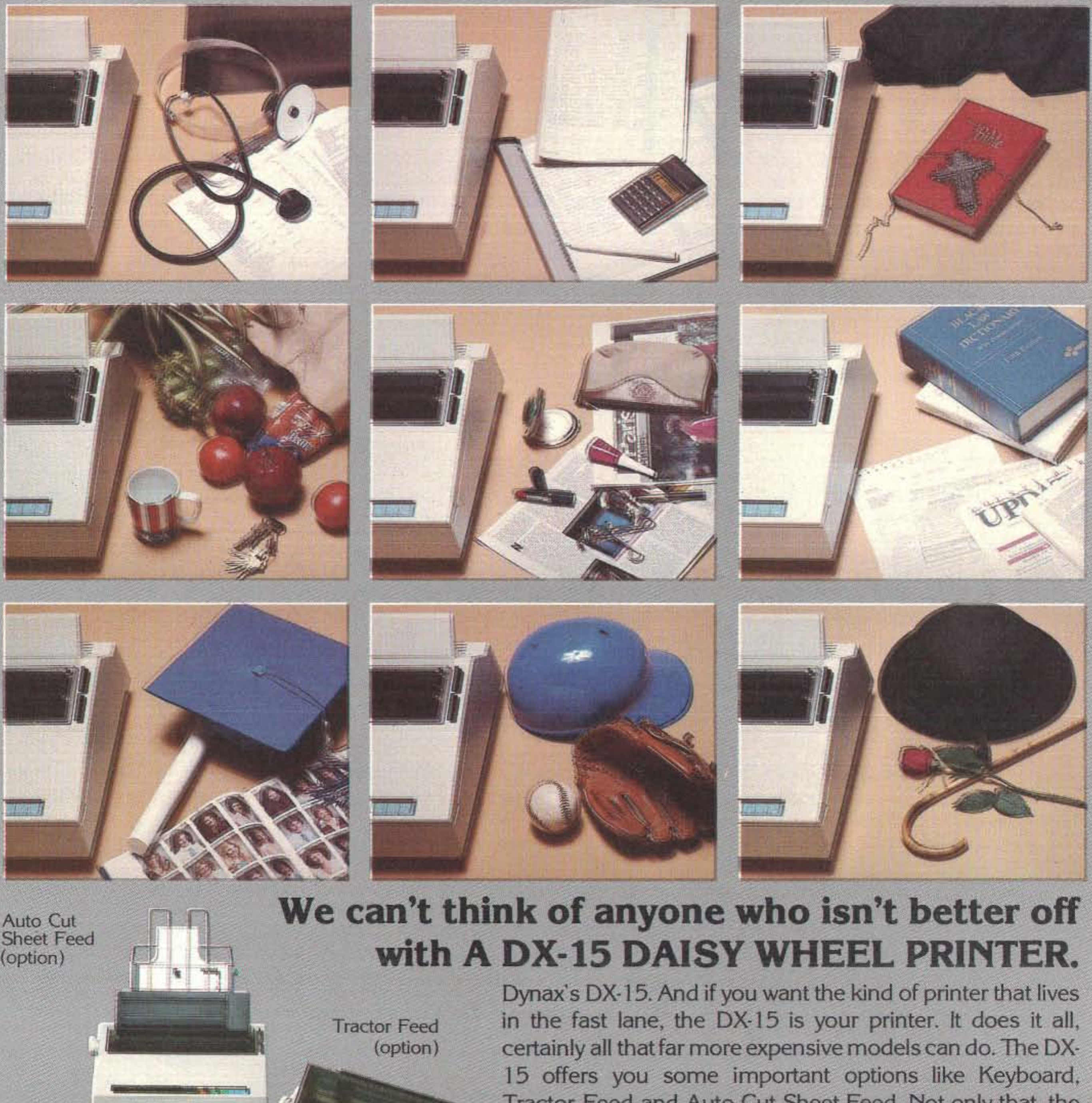

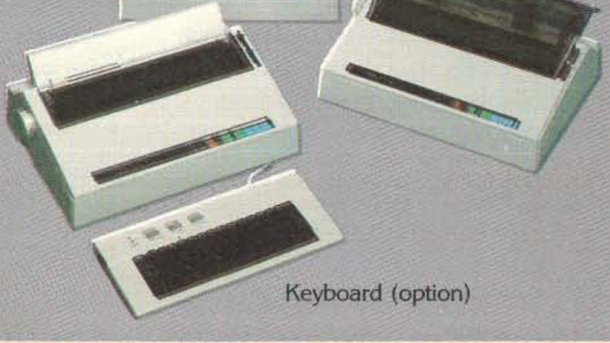

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	Column→ Compare ↓	A First Name	B Last Name	C Area Code	D Telephone
I	=			312	
	not =		W*		
	LTE <=				
	GTE >=				
	LT <				
	GT >				
II	=			415	
	not =		W*		
	LTE < =				
	GTE > =				
	LT <				
	GT >				

Table 3: *A more complicated test chart. The six lines of a test chart (called a* section) *are duplicated for each logical OR operation in the record-selection criteria. This test chart finds all records that have an area code of either 312 or 415 and a last name that doesn't begin with W.*

Col. letter to sort by	:B	:	:	:	:
Ascending = A	:A	:	:	:	:
Descending = D					

Table 4: *Sorting selected records. Records selected by a test chart can be sorted by as many as five keys (the keys are listed in order of decreasing importance). Here, the selected records are to be sorted in ascending order by Last Name (the name of a field in table 1).*

sorting to complex formulas and Boolean logic. Traditionally, you had to use rigid algebraic equations to describe which pieces of data were to be extracted and the conditions for that extraction. Common requests such as the following required Boolean expressions more complex than simple and/or/not statements:

> Invite to the awards banquet all those salespeople who sold at least 25,000 auto parts in August or September, or who exceeded their quotas in either of those months.

Imagine drafting a Boolean statement that describes this ordinary office request:

> Give me the names of customers who live in California and who have made purchases in the last six months. I want the list ordered from the greatest number of purchases to the least with the customers' names alphabetized within the list.

As background, you should know that many years ago I had the Herculean task of teaching symbolic logic to college students. I was a total failure. Symbolic logic is easy for some and impossible for others, and my teaching could not change that. How, then, could I formulate a system to allow the average office worker to make these kinds of choices?

Task analysis was the answer. Let me explain. When we do something, it's usually done in measurable steps. The analysis of those steps—what is to be done, and in what order—is task analysis. Using that approach, it was easy for me to get rid of Boolean formulas. I just had to look at what I needed to do—break it down into discrete, definable steps, and look at it as if it were an instruction book for assembling a food blender.

Let's use a typical mailing list with names, addresses, and telephone numbers for our analysis. The first thing we have to do is to decide what is important: what criteria we want to establish for the information we will extract from our list.

The best graphic example I can give is the test that I take every couple of years at the California Department of Motor Vehicles. (You've probably taken a similar test.) I bring the test to the counter, and the clerk lays a template over it to see what answers appear in the little windows of the template. This is the same way that I can test for certain information in my mailing list. When I say that I want only people with 312 area codes whose last names don't begin with W, I'm actually creating an electronic template. I imagined the telephone information in the form of a chart that looks like table 1. I figured that if I created an electronic template that would allow certain information on my chart to "show through" while other information would be concealed, I would have sidestepped the whole formula-writing process.

But the template would have to be different from a paper with squares cut out of it. It would have to specify which columns of the chart we wanted to test and what we want to test for. Look at the test chart in table 2, which selects only customers whose area codes are 312 and whose last names start with any letter except W (the asterisk is used to match any additional letters in that field).

Now, if you will excuse the fancy talk, what we've got here is a two-dimensional decision matrix (which we will call a *test chart*). It is two-dimensional in that we read from the top down and from left to right to fill in the information—just like finding location F-4 on a city map. Look at what we did. Under the area code column, we read from the left and found an equal sign. On the "equal sign" row, we entered 312. We read that as meaning "Pick out area codes that equal 312." Similarly, the next row reads "Choose any last name that does not equal a group of letters beginning with W."

A More Sophisticated Test Chart

If I thought of the test chart as a filter, everything made sense. But, you ask, "That takes care of the ANDs, but what about OR? How do

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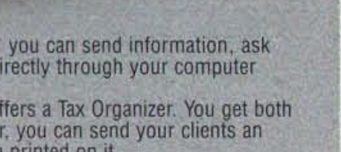

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(5a)

Col→ Row ↓	A Salesper Text = 20	B Quota Number	C #Parts Number	D Month Number	E % Quota Math	
1	Miller, Alan	20,000	21,000	9	1.05	
2	Alberts, Karen	30,000	28,000	8	0.93	
3	Martin, T.W.	1500	1800	7	1.20	
4						
5						

(5b)

Use formulas with (+, −, *, /) for example (A + B)*5, A − B/C, A + B + C
Column E will be equal to:____

Table 5: *The Math data type. When a data column is given the type Math (as shown in table 5a), the database prompts for a formula by which to calculate that column's value for a given row (table 5b).*

	Column→ Compare ↓	A Salesper	B Quota	C #Parts	D Month	E % Quota	
I	=						
	not =						
	LTE <=				9		
	GTE >=			25,000	8		
	LT <						
	GT >						
II	=						
	not =						
	LTE <=				9		
	GTE >=				8	1	
	LT <						
	GT >						

Table 6: *A test chart to select the employees who sold at least 25,000 parts in either August or September* or *who met their quota in either of those two months.*

you select out area codes 312 OR 415?" Well, suppose I make another section of the test chart and add the rule "If you can pass one section of the test, you'll pass the whole test." Then the test looks like table 3. Notice that we have created two sections labeled with roman numerals. The line that divides them is the OR line. All area codes beginning with 312 OR 415 will pass the test, and last names beginning with "W" will be excluded in both cases. Simple enough.

Information Please, the product created out of this exercise, allows five different OR sections. The ANDs within the section are limited only by the number of columns in the chart—up to 255.

It took me more than four months to create this reduction of algebraic equations. I experimented with decision trees, sifting concepts, and reductions of choice pathways. Ultimately, I found that, as usual, common kitchen and schoolroom metaphors turned out to be the best: the filter and the test.

Sorting Results

With my test chart designed, it was easy to see how the program could do sorting. Because I alphabetized the columns across the top of my test chart, I could use the letters of the columns for sorting. First, the program gives me the option of sorting directly from the test-chart screen. When I indicate that I want to sort, I then tell the program which column or columns I want to sort by, and in what order. If I want to alphabetize my mailing list, I should enter my criterion as shown in table 4.

Because I had specified whether a column was text or numeric when I created my information entry chart, the program now knows whether to sort alphabetically or numerically.

Solving Complicated Queries

Now let's go back to the office examples I gave earlier and see how they are handled with this charting method of entering and testing information.

The first problem asks us to find the salespeople who sold at least 25,000 auto parts in August or September *or* who exceeded their quotas in at least one of those months. Let's assume that we have some information entered into this chart (see table 5a).

On this information chart we specified that the Salesperson column would be text by pressing T, that the width of the column would be 10 by typing "10," and that the number of characters in the column could be up to 20 by typing "20." This allows for narrow columns (so more can be viewed at once on the screen) but also permits entry of an extensive amount of information. The next three columns were called Number columns by pressing N after each column name was entered.

Now the last column is interesting. It's a Math column. I wanted this chart to be able to calculate just like a spreadsheet, and that's how it works. After you press M for Math, the message of table 5b appears.

Then we enter the formula. To get the percent of quota each salesperson met, we enter the formula in terms of column letters: "C/B" (the number of parts sold divided by the quota). This formula is calculated instantly each time the cursor moves to a row in the % Quota column.

After all the information is entered (maybe we have figures for several months), we want to find out who sold over 25,000 parts or at least met their quotas in August or September.

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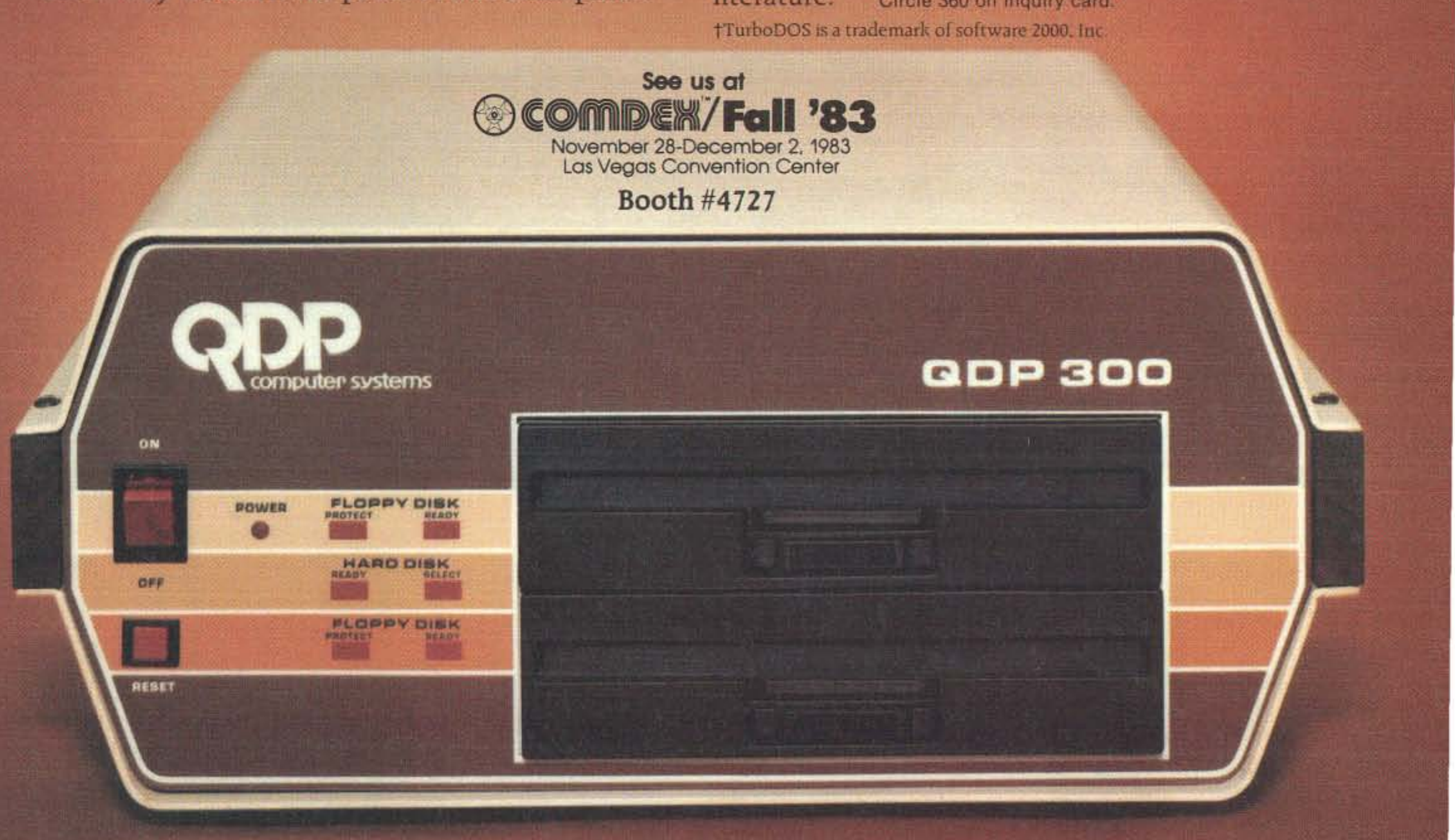

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(7a)

Col→ Row ↓	A Customer Text = 30	B Street Text = 30	C City Text = 20	D State Text = 20	E Zip Number	F Month Number	G Purchase $

(7b)

Column→ Compare ↓	A Customer	B State	C Month	D Purchase
=		CA		
not =				
LTE <=			11	
GTE >=			6	0
LT <				
GT >				

Table 7: *Another test chart. Given the information chart of table 7a, the test chart of table 7b selects the records of all California clients who have made a purchase between June and November.*

We find this out once we create the test chart of table 6. When we give the test, the results are displayed immediately. Only Miller and Alberts pass.

The second problem, which I cited earlier (on page 168), is solved in the same way but also involves the extra step of sorting. We not only need to select the California customers who made purchases in the last six months (let's assume it's December, and we'll be searching June through November), but we must arrange the purchase amounts numerically from largest purchase to smallest and then order the customers' names alphabetically from A to Z within the list. Assume that our information chart has the headings given in table 7a; then our test chart will look like table 7b. Once the test information is entered, we simply state that we want to sort the Purchase column in descending order and the Customer column in ascending order. Our problem is solved.

Notice that the graphics are simple yet clear. You don't need windows or mice to make charts or to analyze the information in them. The last thing that office workers with messy desks want is to have a messy computer screen. Fancy fonts, graphics, and anything that does not immediately enhance the user's understanding of the task are simply other learning barriers. Good software will lower barriers, not raise them, and will simplify work, not make it more complex.■

Martin Dean, chairman of the board of Select Information Systems (919 Sir Francis Drake Blvd., Kentfield, CA 94904), was a lawyer for 15 years before beginning Select Information Systems, a company he started out of his dissatisfaction with existing microcomputer software. Among his interests are photography and furniture building.

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Integrating Voice in the Office World

How "voice recognition" and "voice as data" simplify the user interface in the business world

by Robert T. Nicholson

If industry predictions are correct, by the end of the decade 80 percent of the work force in the United States will be engaged in office work and information handling. As the number of office workers increases, so does the competition for the growing office computer market. Established workstation manufacturers, new start-up companies, and traditional word-processor and communications manufacturers are already rushing to introduce office systems.

Most of these systems perform some combination of these functions: word processing, electronic spreadsheet, electronic mail, and calendar appointments. Some systems also provide decision support and business-graphics capabilities. Typically, the purchase of such a system is justified by the need for a particular application; the user is willing to live with a poor user interface or an incomplete system to meet that immediate need.

However, as the number and diversity of users increases, office systems must offer more integrated sets of applications with far better interfaces to accommodate the needs of a broad range of users and to eliminate expensive and time-consuming training.

Office System Interfaces

Current systems attempt to do this by starting with a familiar model. Some use the workstation screen to represent a desktop, with small icons (graphic symbols) used to depict objects that might be found in the office (such as file folders or memos). Windows on the screen contain the user's current work, and the user may freely interrupt one task to work on another simply by moving to another window (see photo 1).

To begin a new task, the user "opens" one of the objects on the desktop. The user selects the desired object by pointing to an icon on the screen using a mouse or cursor keys, and then opens the object by pressing a button or key. When the object is opened a new window is created to display its contents.

Other activities, such as deleting, mailing, or printing, can be chosen by pressing a *softkey.* As shown in photo 1, softkeys are function keys whose tasks are labeled on the workstation screen. Whenever the user selects a function by pressing a key, the labels change to show the new options or functions that become available.

These interfaces are a big improvement over older systems, but they still limit the user to communication via the screen and the keyboard. One way to overcome this limitation is to integrate voice communication into the computer system.

Voice is the most natural form of human communication. It is faster than typing, can be done from anywhere in the office, and does not require a keyboard (a fact that will please many managers who have resisted the idea of typing). In addition, psychologists and learning specialists believe that listening to information, instead of reading it, may speed learning and improve retention.

Voice Applications

The ability to record a spoken message and store it digitally on a computer system makes possible a whole new range of applications.

Combined with electronic mail, the digital recordings can be used as *voice messages.* Office users can quickly create short, impromptu messages and dispatch them to other users of the system without ever using a keyboard. It is also possible to provide "mailbox" files for voice messages and to allow users to call in over a standard telephone to record and play back their voice mail. This voice-messaging process is especially important in large corporations where managers and professionals may spend 65 to 95 percent of their time in communication.

Integrating telephone functions into the desktop workstation has other advantages: the system can maintain a telephone directory for automatic dialing and can allow the user to leave a typed or recorded message

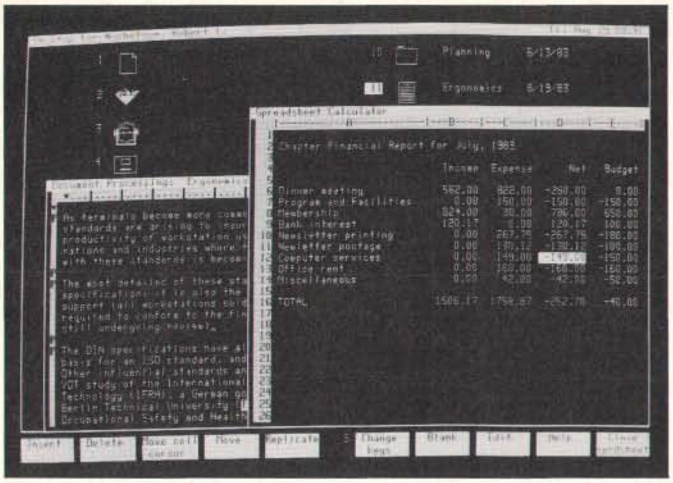

Photo 1: *The workstation screen can be divided into several windows, each dedicated to a particular task. In the background window are the icons that represent various objects in the user's office. The two windows nearer the front are being used to work on a spreadsheet and a document. The labels on the softkeys at the bottom of the screen allow the user to select functions to be performed.*

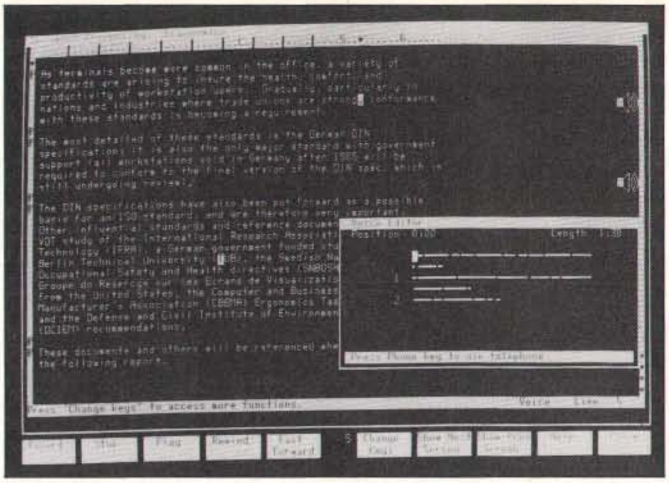

Photo 2: *The small window in the foreground contains a visual representation of a recording made by the user. Solid lines show continuous speech, while breaks indicate pauses. The numbers mark reference points selected by the user. By moving the cursor around this display and using INSERT and DELETE keys on the keyboard, the user can edit the recording.*

when someone doesn't answer.

Another important office function is dictation and voice editing. A voice editor allows the user to see and edit a visual representation of what is being recorded, just as a word processor allows the user to edit text. As shown in photo 2, a line is drawn while the user speaks, with breaks in the line to show pauses. (This feedback provides a reassuring indication that the system is working.) The numbers shown are points that the user has marked for future reference using a Mark key. The visual representation is important, because it allows the user to go back over the completed recording and insert or delete recorded material using editing keys. The user can also find parts of the recording to edit by using the Rewind, Fast Forward, Play, and Stop softkeys. Only when the recording says exactly what the user wants to say is it mailed to a secretary for typing.

Similarly, voice input can be used to "enter" data in a form, for later typing by a clerk or secretary. For example, an executive could be prompted for each of the fields on an expense-report form and could verbally record the expenses. The finished "form" could then be sent to the accounting department, where a clerk could play back the responses and type them into the accounting system.

Voice recordings can also be used for document annotation. Frequently, paper documents are passed around an office for review and comments. These comments are usually scribbled in the margin or passed on verbally when the document is returned. To a large extent, this ability is lost when documents are circulated in electronic form using mail systems. With a voice annotation scheme, however, users can record verbal comments and then mail the "marked" document back to its creator. The location of each voice annotation is shown by a speaker symbol in the margin of the document, as shown in photo 3.

System output can also be enhanced via voice. To aid the user in learning to use sophisticated features, most systems today offer help functions that provide on-line information. The problem with these systems is that there is no way to try an operation while reading the help instructions. This problem can be overcome by providing an audio help facility (in addition to the standard help text). The user can then try out an operation while listening to a recorded help tutorial. Using prerecorded instructional material, full on-line training systems could be developed to verbally correct the user as mistakes are made.

Other uses for voice output could include notification of events ("You have an urgent message waiting") and elaboration or emphasis ("Note that earning are 60 percent over projections").

These applications share one important attribute: the system treats the recorded information as data and has no knowledge of its content or meaning. Applications of this type are called voice or *voice-as-data* functions, to distinguish them from *voice-recognition* applications, which involve processing and recognition of the audio input.

To date, speech input has been used mostly in applications where "hands-free" data entry was required and where the necessary vocabulary was limited. For example, workers unloading trucks for private postal services can read destination codes into a clip-on microphone before placing a parcel on the conveyor belt; the system can then automatically route the parcel to the correct outgoing truck.

Hands-free operation could also have some applications in the office. It might be useful for a typist to verbally give system commands while typing or for a graphic designer to give the machine verbal instructions

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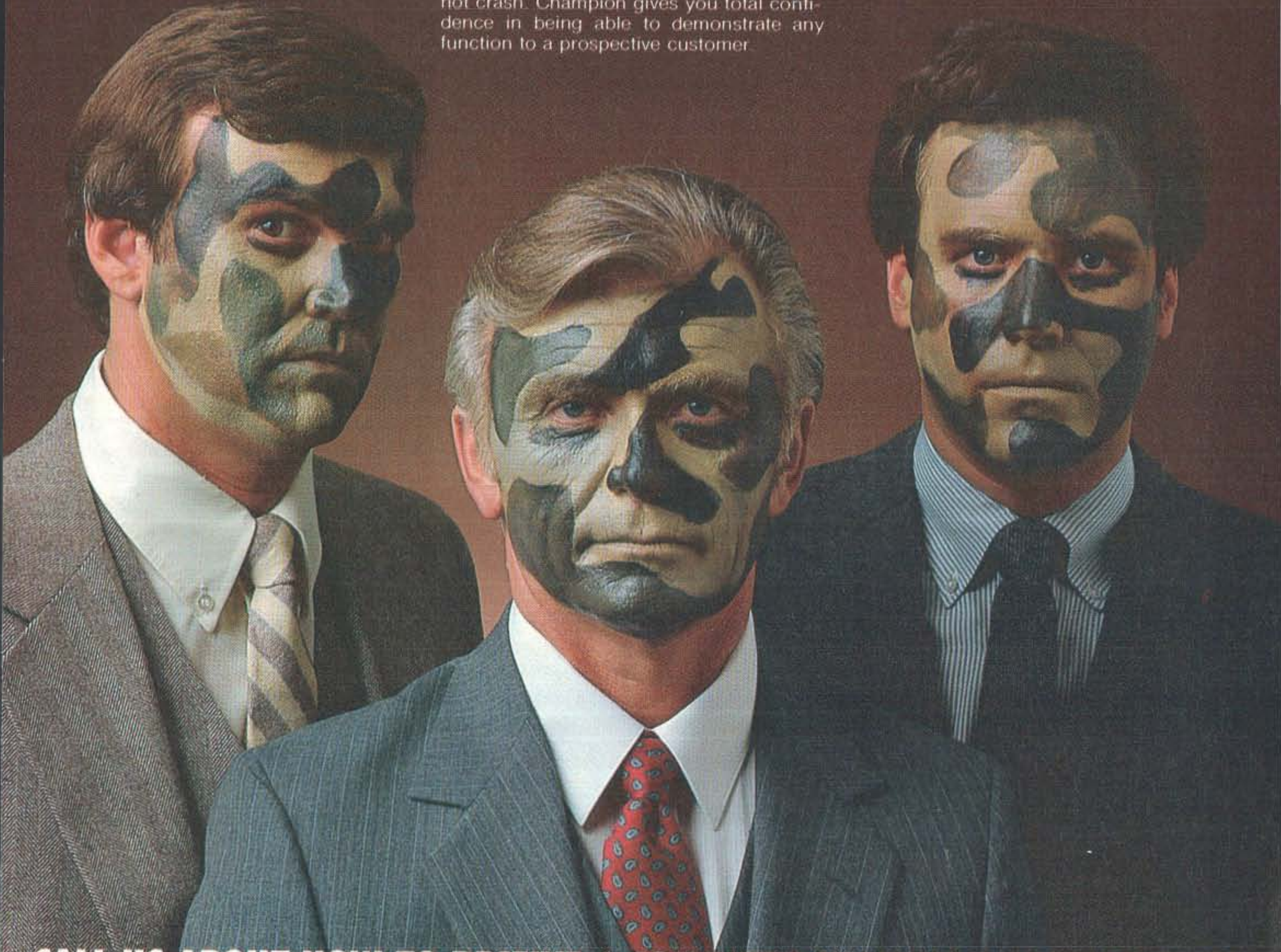

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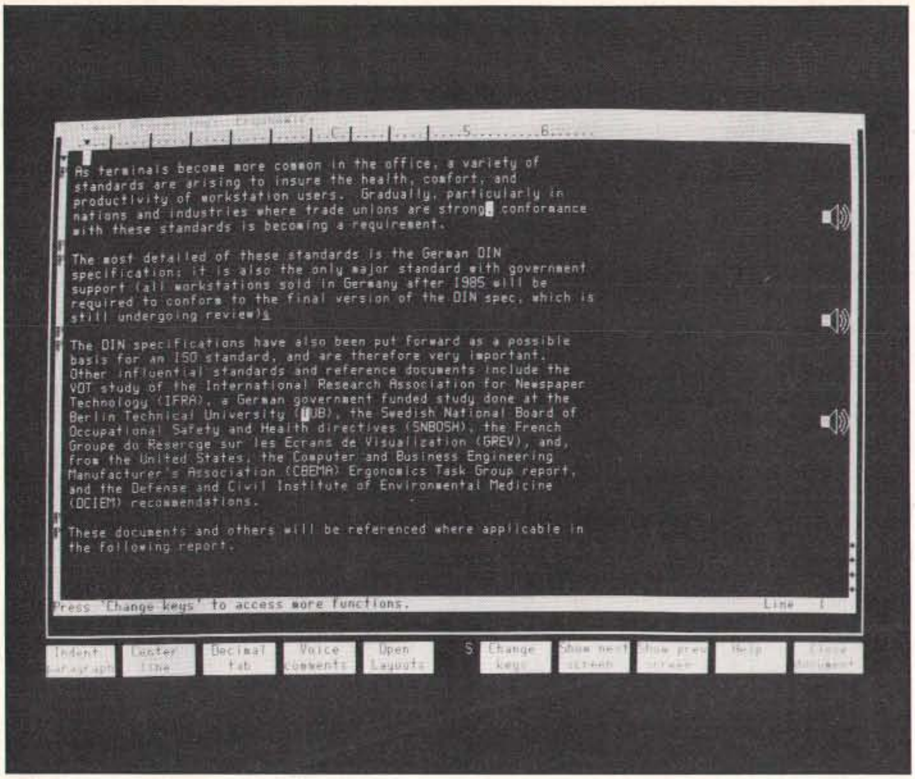

As terminals become more common in the office, a variety of standards are arising to insure the health, comfort, and productivity of workstation users. Gradually, particularly in nations and industries where trade unions are strong, conformance with these standards is becoming a requirement.

The most detailed of these standards is the German DIN specification: it is also the only major standard with government support (all workstations sold in Germany after 1985 will be required to conform to the final version of the DIN spec, which is still undergoing review).

The DIN specifications have also been put forward as a possible basis for an ISO standard, and are therefore very important. Other influential standards and reference documents include the VDT study of the International Research Association for Newspaper Technology (IFRA), a German government funded study done at the Berlin Technical University (TUB), the Swedish National Board of Occupational Safety and Health directives (SNBOSH), the French Groupe du Resercge sur les Ecrans de Visualization (GREV), and, from the United States, the Computer and Business Engineering Manufacturer's Association (CBEMA) Ergonomics Task Group report, and the Defense and Civil Institute of Environmental Medicine (DCIEM) recommendations.

These documents and others will be referenced where applicable in the following report.

Press 'Change keys' to access more functions.

Photo 3: *Speaker icons in the margin of this document show points where a reviewer has recorded voice comments that can be played back by the original author of the document.*

while drawing with a mouse.

With improved speech recognition techniques, however, other kinds of applications are appearing. One new application combines speech input with a pseudo-natural-language interpreter to allow verbal database queries.

Farther out on the horizon are direct-speech-transcription systems. The idea of such a system is to produce ASCII (American National Standard Code for Information Interchange) text from spoken input, thus allowing users to produce and print finished documents without using a keyboard.

As attractive as these applications are, they also present serious challenges to the interface designer.

Voice Interface Challenges

The major obstacle to overcome is the intimidation that some people feel when presented with a microphone. A first step in this direction is integrating the telephone into the workstation. The telephone is a familiar device that we all use; by making it a part of the workstation, the interface designer gives the user a chance to gradually become comfortable with the idea of talking to the machine.

Another way to ease the user over the microphone fear is to eliminate any system demands on the user and to maintain a strong feeling of user control. Many people, for example, freeze up when a telephone answering machine begins its familiar litany, "At the sound of the tone, you have 60 seconds to leave your message." With an integrated voice and data workstation, on the other hand, the user can be left in control of the situation: "When you are ready to leave your message, press the Record key and begin speaking." Also, visual feedback like that provided by the voice editor can be a valuable confidence-builder for new users.

Another factor in maintaining the user's sense of control is good response time. When the user presses a control key such as Record, Play, or Stop, the system must respond within about .1 second. When the user picks up the telephone receiver, the dial tone must begin within 2 to 3 seconds. Or, when voice is used in a conversational activity such as prompting, response time should be close to .5 second. This simulates the natural pace of human conversations and avoids the stress of rapid-fire questions from the system.

In any voice application the quality of voice reproduction is important. Voice prompts from the system need to be clear and understandable. Voice

Digital Voice Encoding

Digital voice encoding is a process that converts an analog waveform into a digitally coded representation that can later be reconverted to analog form. Once in digital form, the voice data can be transmitted, stored, and processed by a computer—an important attribute as voice and data integration become more common.

The standard form of encoding used in the telephone industry is referred to as pulse-code modulation *(PCM). In PCM, an analog waveform is sampled at regular intervals, and the amplitude of each sample is represented as a binary number. With 8-bit PCM, for example, 1 byte is used to represent the amplitude; thus, the representable values range from −128 to 127, in 255 equal steps. This representation is called a linear encoding.*

Better sound reproduction can be achieved, however, if the steps are fine at low amplitudes and coarse at high amplitudes where the human ear is not as discerning. Therefore, a U.S. standard has evolved that uses one bit for a sign, four bits for a mantissa, and three bits for an exponent. The resulting nonlinear code is called mu-law *(or* mu-255*) encoding.*

Mu-law encoding is capable of good telephone quality sound reproduction. In fact, it is the basis for most digital telephone systems within the United States (a similar system called A-law *is used in Europe). Unfortunately, mu-law requires a great deal of data. Because the sampling rate used is 8000 Hz, 1 second of sound requires 8000 bytes of data, and 5 minutes requires over 2 megabytes!*

Efforts to reduce the volume of data have resulted in a technique called differential pulse-code modulation, *(DPCM), in which the data value stored represents the amplitude difference between samples, instead of the amplitude of the sample itself. This technique can be further improved by storing an* adaptive differential pulse-code modulation *(ADPCM). In this technique, the scale of the differential value* *is varied based on previous differentials. Thus, if several successive samples contain large differentials, each will be considered a multiple of the preceding data value, so that a steep slope can be approximated with few bits. In fact, ADPCM produces good sound with 2-, 3-, or 4-bit data values, instead of the 8-bit values used in standard PCM. (The ADPCM algorithm is available in IC form from Oki Semiconductor Corporation and is described in detail in the June 1983 BYTE.)*

An alternate technique for encoding voice is called delta modulation. *In delta modulation, each segment of the wave is approximated by a line segment with a slope of 1 or −1. The direction of the slope can be represented with a single bit, rather than the 4 or 8 bits used in PCM algorithms. Of course, simple delta modulation isn't good enough for most applications because restricting the slope to 1 or −1 makes it difficult to model steeply climbing or falling waves.*

A somewhat better algorithm is called continuously-variable-slope delta *modulation (CVSD). In CVSD, if the slope value of the data bit is the same for three or four samples, the slope is doubled. This prevents the approximation from falling too far behind when the slope of the wave becomes steep. Still, to get a close approximation with CVSD, many samples are required. For good-quality voice reproduction, as many as 32,000 samples (or 4000 bytes) per second may be required.*

For applications where voice quality is less important, linear predictive coding *(LPC) can store voice with very little data (200 to 300 bytes per second). LPC is based on a mathematical model of the human vocal tract. The data values stored at each sample point are actually coefficients of a formula for reproducing the desired sound. One of the most familiar products using LPC is Texas Instruments' "Speak & Spell."*

Photo 4: *The Voicestation 1 provides the integration needed for office applications by combining a bit-mapped display and a telephone in a single compact unit. The workstation is connected to a central system over standard office telephone wiring.*

messages must be reproduced with enough fidelity to allow the speaker to be recognized and to allow nuances of tone to be detected. In other words, the quality of sound must be at least as good as a good telephone connection. To provide this quality, the system must digitize and then regenerate the voice of the speaker via waveform encoding, instead of using artificial speech-synthesis chips.

Applications that process speech have an additional problem because available speech-input devices either have a limited vocabulary or must be trained to understand specific users. Device training is often viewed as a one-time process, but it really isn't; voices may change because of colds, temporary help may be hired, or people might use one another's workstations. Therefore, when designing a speech-input system, considerable effort should be spent to make the training process as simple as possible.

Virtual Personal Computer Architecture

Meeting the various user-interface requirements places some heavy demands on the office computer system. Chief among these is the ability to transfer and store large quantities of data. Storing 1 second of high-quality digitized-voice data can require 2000 to 8000 bytes of data, depending on what sort of compression is used (see the text box "Digital-Voice Encoding" for more information). Recording just a few minutes of dictation can require that more than a megabyte of data be processed, compressed, and stored, all in real time. Moreover, the hardware to do this must not add too much to the cost of the system, or it will not be competitive in the office-systems market.

To meet these goals we need a "virtual personal computer," an architecture that allows expensive voice, storage, and communications resources to be shared, while delivering performance comparable to a dedicated personal computer. An example of such a system is the Sydis Information Manager (SIM) from Sydis Inc. (see figure 1). Its architecture, described later, is a direct product of the requirements for an integrated voice and data interface.

The SIM is a centralized facility containing all of the expensive resources required in the office. Processing power is provided by multiple 68000 microprocessors including a system master and multiple application servers, voice servers, and file servers. The system master, which can be made redundant for increased reliability, allocates and coordinates

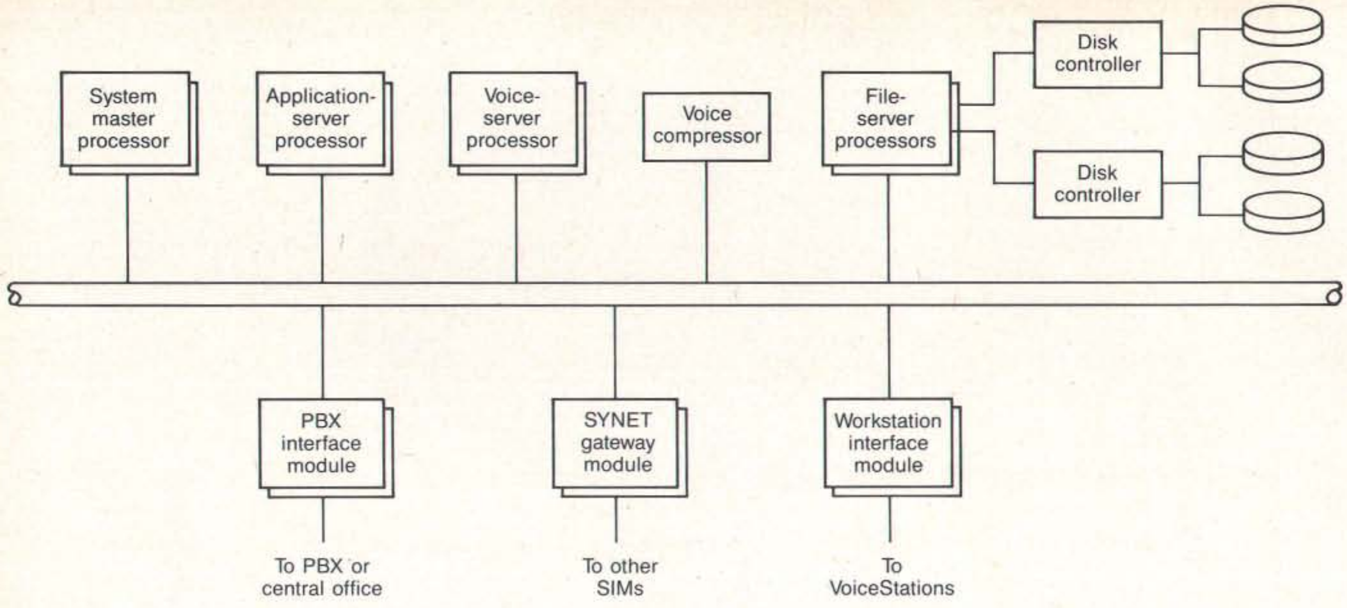

Figure 1: *The Sydis Information Manager (SIM) architecture combines shared resources for many users in a central location. In addition to multiple 68000 processors used for application programs, voice processing, and file-systems I/O, the SIM includes interfaces to the office PBX and to local networks or other SIMs.*

the other resources of the SIM. The application-server processors perform the general work of the system, running office application programs for users. One or more voice servers are used as "digital tape recorders" to handle the voice-to-disk and disk-to-voice transfers as well as voice editing. Finally, one or more file servers handle all mass-storage operations.

Mass storage within the SIM is provided by one or more 160-megabyte Winchester disks and a 160-megabyte streaming-tape drive for backup. Other shared resources include interfaces to the office Private Branch Exchange (PBX), which handles telephone functions such as forwarding and transferring calls, gateways to other SIMs, and interfaces for the desktop workstations.

The desktop workstations, called Voicestations, are connected to the SIM in a star configuration. Connections are made over standard two-wire telephone lines, eliminating the expense of rewiring the office. Each connection supports four 64K-bps (bits-per-second) communication channels, providing the high bandwidth required to match the performance of a desktop computer. One of the four channels is used by the system for command and status information, another is reserved for voice, and the remaining two are available for data.

The Voicestation itself, shown in photo 4, features an integrated telephone, a speakerphone, and a high-resolution (832 by 608) bit-mapped display. A local 68008 processor and 128,000 bytes of RAM allow the workstation to perform the windowing functions required by the interface. Additional devices can be attached to the Voicestation, including a mouse, a foot pedal for use in transcribing dictation, and a local printer.

In summary, the architectural features needed to integrate voice capabilities into an office system include:

- a central facility to allow sharing of expensive resources such as mass storage and voice processors
- large mass-storage capacity to allow storage of voice data
- a low-cost, high-speed link to desktop workstations
- workstations with enough local power to support graphics, windowing, and useful local I/O (input/output) devices

Software Requirements

Integration of voice and data also places demands on the system software. The Sydis system is based on Microsoft's Xenix operating system, which is fully compatible with Bell Laboratories' Unix System III. To provide the performance necessary for voice applications, Sydis has made several enhancements to the operating system.

One major addition is a network interprocess-communication facility (NIPC), which allows reliable and fast communication between processes even though they may be running on different processors. This facility has many uses, including resource requests and allocations among processors and communication within the file system.

To allow uses on different application servers to share mass storage, the file system has been networked. File-system calls on an application server are now converted to NIPC messages, which are transmitted to the appropriate file server over a 128-million bps system bus. In addition, the system has been enhanced so that multiple disks on multiple file servers can be made to appear to the application programs as a single file hierarchy, so that the physical location of any particular file is transparent to the program.

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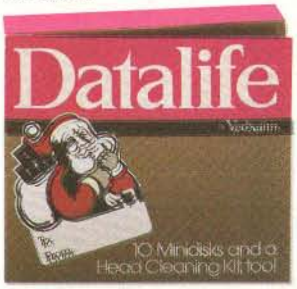
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The file system has also been optimized for the large files and large data transfers required for voice applications. Disk space is now allocated in blocks of 4096 or 8192 bytes, rather than the 512-byte blocks traditionally used on Unix systems. In addition, the linked list that Unix file systems use to keep track of free space has been replaced by a bit map showing the state of each cylinder and sector on the disk. In this way, blocks can be allocated in an optimum way, taking into account disk latency, to ensure high-speed transfers for large streams of voice data.

The software requirements for the system master and voice server were somewhat different. These processors perform no direct disk I/O but must respond rapidly to interrupts to handle voice data in real-time. To meet this need, these processors run a stripped-down version of the operating-system kernel. All required software has been written as interrupt routines or as system processors, to minimize context switching times.

These and other enhancements provide an operating system capable of concurrently transferring multiple streams of voice data to and from disk, while still handling the requirements of more traditional office applications such as word processing and electronic mail.

At the user-interface level, the standard Unix shell or command interpreter has been replaced by a new shell that models the user's office environment and provides the object and softkey selection facilities seen in photos 1–3.

Conclusions

Integrated voice and data systems will be widely used in office automation because they enhance communications, the most time-consuming office activity. As always, some purchasers will accept a poor interface to have these features as soon as they can. But for these systems to be widely accepted, comfortable, responsive interfaces must be designed.

Supporting high-quality voice interfaces requires the ability to rapidly move and store large volumes of data and to effectively share limited or expensive system resources. The architectures needed to provide these capabilities may have as big an impact as the voice systems themselves. ■

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Robert T. Nicholson is a member of the technical staff at Sydis Inc. (410 East Plumeria Dr., San Jose, CA 95134).

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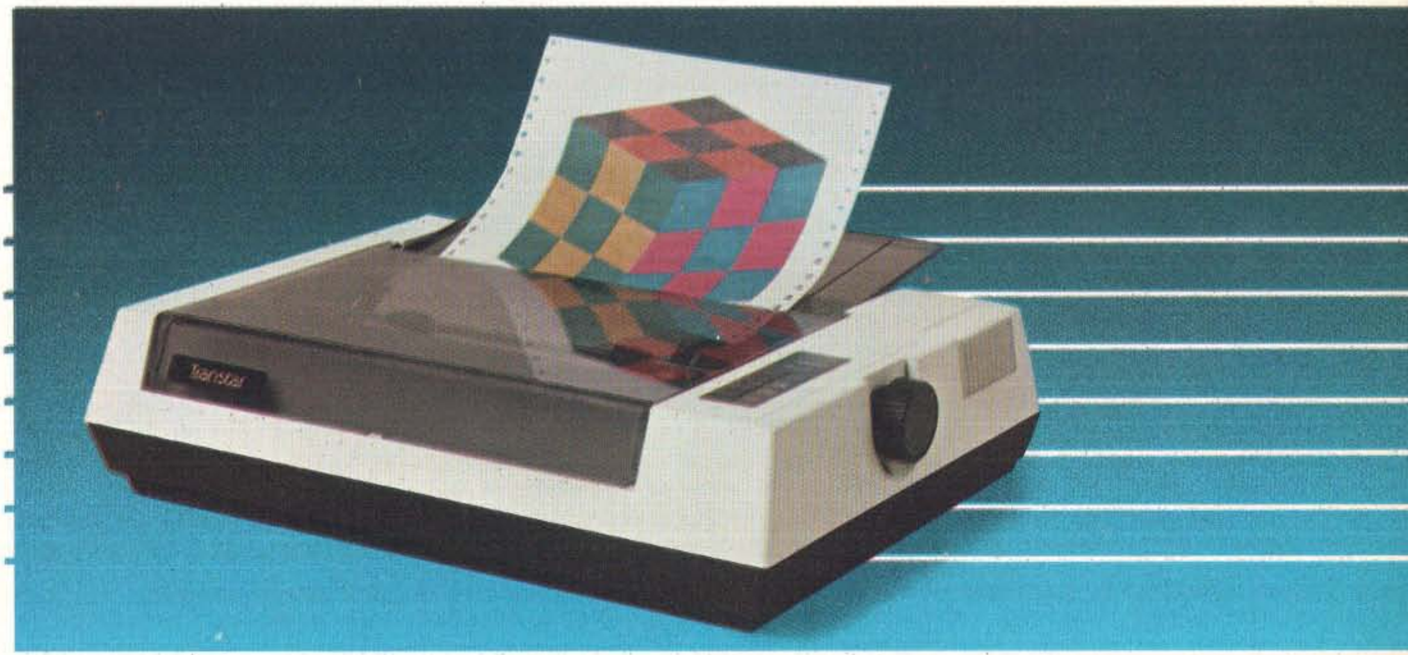

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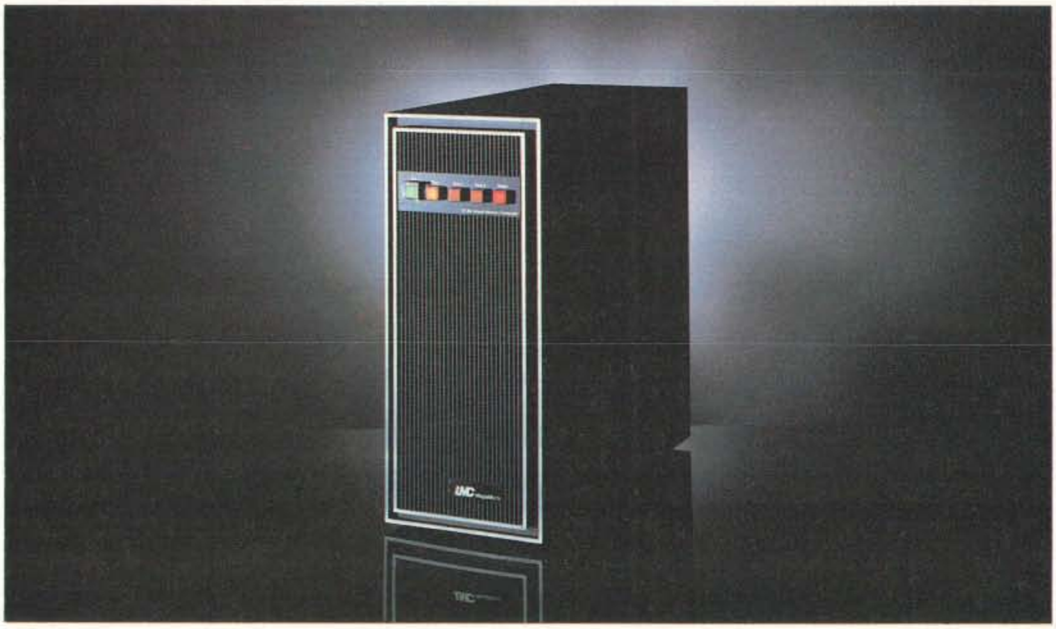

LMC's MegaMicro is built around the newest state-of-the-art VLSI logic—the 16000 family developed by National Semiconductor. Each MegaMicro is supplied with UNITY—HCR's full Bell-licensed UNIX operating system—as well as FORTRAN and C. Also standard are hardware virtual memory and hardware floating point, a half Meg. of RAM and a very fast 20 Meg. Winchester hard disk. The result is a computer with the performance of a large mini, at a "micro" price. For example, the MegaMicro does 161,000 double-precision (64-bit) floating point multiplications per second. All this at a realistic price, and even less with OEM and quantity discounts (about the same as a single IBM XT or Apple LISA). The result is a cost per "work-station" far lower than similarly configured (and less powerful) "personals."

Because the MegaMicro is powerful, inexpensive and designed around the Multibus (IEE 796) (which means it has a completely "open" architecture), it is an ideal choice for the OEM wishing to supply powerful applications software solutions on a microcomputer.

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The Starburst User Interface

Linking multiple programs via custom-menu software

by Steven Vandor

Micropro's Starburst, a software package that facilitates efficient menu design, can ease construction and modification of applications software by creating a new, more appropriate interface between the terminal screen and the system operator.

Starburst makes the interface between programs such as Wordstar and Calcstar more obvious, providing a link for Micropro's integrated software packages. More important, you can use the program to build an integrated system using almost any type of software. It works with Micropro software as well as with other programs, and it requires no special or experimental hardware.

Starburst streamlines and smooths the interface between programs, making it unnecessary for the user of a set of applications programs to know the commands needed to get each program running. It does not, however, address the deficiencies in the user interface of a particular program.

Uses for Starburst

A business that requires many different applications programs can benefit from Starburst. For example, a company might use Datastar (part of Micropro's database-management system, Infostar) to collect data and enter it into a database. A report on the entered data (created with a program such as Reportstar, also part of Infostar) could then be produced and collated into a daily report written with Wordstar. This process—data entry through report distribution—requires the use of several programs and several files.

Indeed, such a task consists of a series of smaller ones. First, the data must be entered into a file, then processed (or reported), then inserted into a larger file so the report can be distributed. And along the way, backup copies of data and report files must be made. Starburst makes it appear to the user that these smaller tasks have been combined into one operation. This capability—taking the numerous steps involved in a large task and reducing them to one step—permits design of applications programs that suit operation by inexperienced users.

Starburst provides an interface that shields the user from the smaller steps a project often requires. And by protecting the user, it adds a measure of protection to the system. By using Starburst to set up a task in advance, you can ensure that a series of required tasks will be executed correctly. Steps such as backup, for instance, can be set up to occur at the appropriate time.

The System Interface

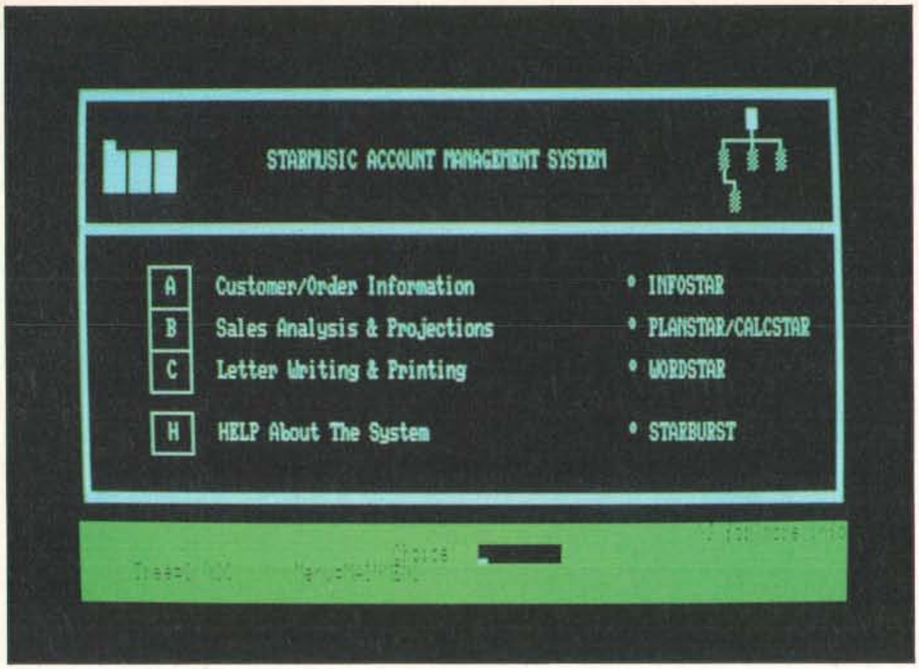
Micropro designed Starburst to be compatible with as many machines as possible. The program is designed to work on virtually any business microcomputer. Starburst can use a system with a simple terminal and an addressable cursor. Screen updating is speeded by memory mapping on those computers that provide it. Starburst can also utilize graphics characters.

At a basic level, any user interface is under the control of system hardware. This is a curse to designers trying to provide hardware-independent software. Use of icons (symbols rather than words), windows, mice, and other advanced software features is impossible without substantial hardware dedicated to them.

Recent hardware innovations, however, such as oversized bit-mapped displays and the mouse, have appeared in advance of functionally complementary software. Although this hardware has captured the imagination of the marketplace, high prices have prevented its widespread purchase.

Other problems have slowed the mass marketing of this new hardware. Execution speed, for instance, has been a crucial factor. If a program's interface is interesting to look at, simple to learn, but slow as molasses, that software has severely limited potential.

Starburst does not require or support use of a mouse because only a limited number of applications programs take full advantage of the



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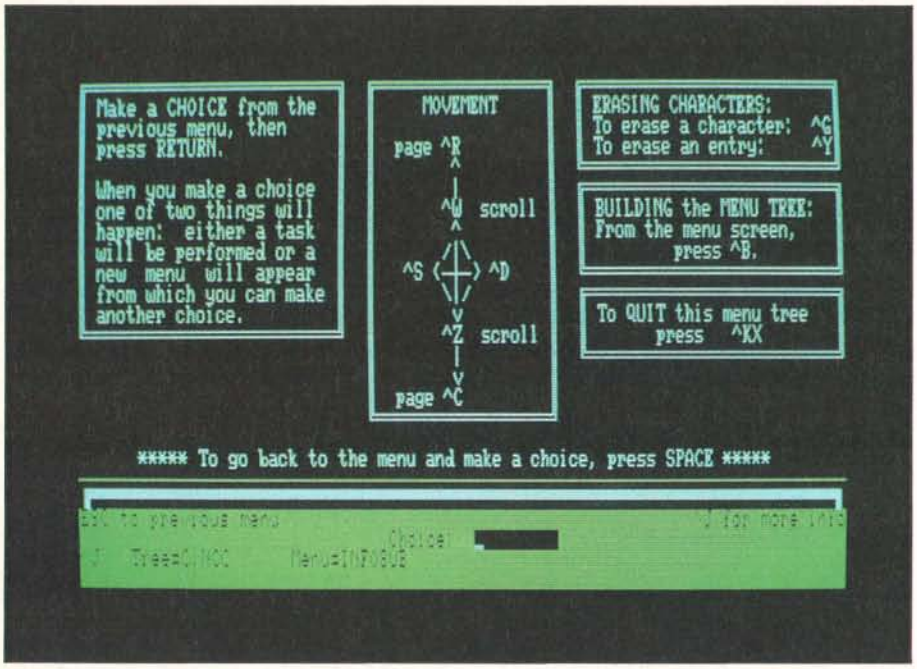
 C   Letter Writing & Printing         * WORDSTAR

 H   HELP About The System             * STARBURST
```

Photo 1: *A typical user-designed Starburst menu. The graphics at the top of the screen were created using the IBM PC's graphics set.*



```
Make a CHOICE from the         MOVEMENT        ERASING CHARACTERS:
previous menu, then                            To erase a character:  ^G
press RETURN.                  page ^R         To erase an entry:     ^Y
                                    ^
When you make a choice              |
one of two things will             ^W  scroll  BUILDING the MENU TREE:
happen:  either a task              ^          From the menu screen,
will be performed or a             /|\                press ^B.
new  menu  will appear       ^S <--+--> ^D
from which you can make            \|/
another choice.                     v          To QUIT this menu tree
                                   ^Z  scroll        press   ^KX
                                    |
                                    v
                               page ^C

***** To go back to the menu and make a choice, press SPACE *****
```

Photo 2: *You could supplement this general Help screen with detailed Help screens that suit the system's specific menus and functions.*

mouse's capabilities at this time. In addition, the mechanics of using a mouse can prove time-consuming and may not provide a productivity return proportionate to the effort of using one. Starburst will not be a mouse-oriented product until mouse-driven applications software becomes more standard.

Once the hardware problems are solved, software developers are responsible for providing most of the screen interfaces for microcomputers. (Companies such as Micropro and Visicorp provide many of those interfaces with their widely distributed software.) Even for firms that distribute software internationally, hardware is a major concern. The tradeoff is obvious: a software vendor can support just a few computers, taking a customized approach to the user interface, or (as in the case of Starburst) attempt a more general approach to afford products wider distribution.

Creating Menus

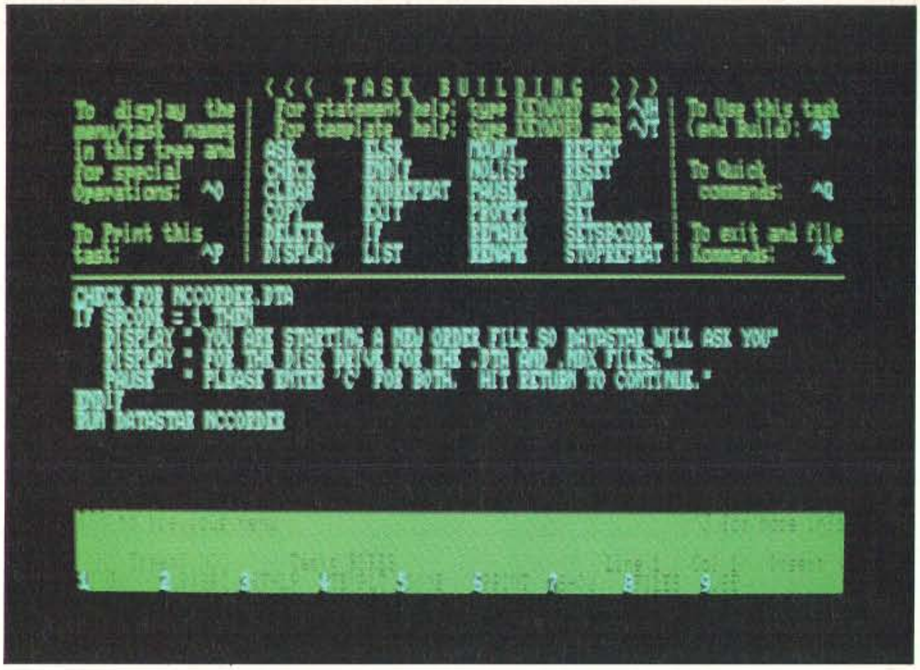
For the software designer/integrator, Starburst is a productivity tool. In a customized data-processing system, for example, it can handle all the external functions such as user input and output. You, the system designer (referred to as the "builder" in Starburst documentation), use the software to create menus for the user interface. You decide whether the menus are to be similar or dissimilar, and, depending on the hardware, you can use both text and graphics characters in the design. Starburst will then display the menu and execute the selections the operator makes. Using Starburst to string together individual programs that comprise a larger application can save a lot of programming time. It also gives the screen a polished appearance.

The menus in a system using Starburst all have the same general appearance, but you determine their contents. General information for functions such as cursor movement and menu choices is provided directly to the operator through a function or control key. In addition, you can write Help screens into the user interface to reduce your dependence on the documentation. Perhaps more significant, a menu system that includes help screens tied directly to the menus can reduce the amount of time required to learn to use the system.

Starburst also can provide other benefits for the system integrator. Beyond fast menu design, it can specify the tasks that a particular system will perform. It recognizes 24 commands to handle most system functions. Besides running applications programs, these commands allow the task design to include file copying and renaming, conditional logic, looping, variable assignment, and file locating. And you can write programs in BASIC, Pascal, or any other language to accomplish complicated, nonstandard operations such as extractions. (A description of these task commands appears later in this article.)

Starburst offers a quick way to make every system look and behave similarly. Using Starburst, a partitioned accounting system (one that includes components such as programs that serve as a general ledger, a record of accounts receivable and payable, a payroll, and an inventory) can exhibit a high degree of visual and functional similarity. It may, of course, be advantageous to differentiate among this system's modules, and for that reason, Starburst permits instant visual identification because it can take advantage of the graphics capabilities of many computers.

A simple but effective way to use graphics is demonstrated in the training files included with Starburst. On each menu in the training system, a graphics figure that represents the system (starting at one menu and proceeding to other levels of menus) is displayed in the upper right-hand corner of the screen. The menu currently in use is highlighted in the figure (see photo 1). This design helps keep the user from getting lost.



<<< TASK BUILDING >>>
To display the menu/task names in this tree and for special Operations: ^O
To Print this task: ^P
For statement help: type KEYWORD and ^H
For template help: type KEYWORD and ^T
ASK
CHECK
CLEAR
COPY
DELETE
DISPLAY
ELSE
ENDIF
ENDREPEAT
EXIT
IF
LIST
MOUNT
NOLIST
PAUSE
PROMPT
REMARK
RENAME
REPEAT
RESET
RUN
SET
SETSBCODE
STOPREPEAT
To Use this task (and Build): ^G
To Quick commands: ^Q
To exit and file Kommands: ^K

```
CHECK FOR MCCORDER.DTA
IF SBCODE = 1 THEN
   DISPLAY "YOU ARE STARTING A NEW ORDER FILE SO DATASTAR WILL ASK YOU"
   DISPLAY "FOR THE DISK DRIVE FOR THE .DTA AND .NDX FILES."
   PAUSE   "PLEASE ENTER 'C' FOR BOTH. HIT RETURN TO CONTINUE."
ENDIF
RUN DATASTAR MCCORDER
```

Photo 3: *On this screen, the programmer specifies which actions will occur when an operator makes a menu selection. Although the final statement on the screen says to run Datastar, it could indicate any program.*

Starburst's Screen Interface

The Starburst program uses an enhanced menu-driven interface and includes the basic Wordstar screen editor as one of its functional parts. Other commands for system building use mnemonics and graphics extensively. For example, when a menu has been laid out and you want to specify that its choice A should perform a particular series of actions, you merely place the cursor on the A character and press Control-L to *link* the choice to a set of task action statements. You can specify and name the actions then, or you can specify the actions at a later time.

When you are using Starburst to build a system, a brief summary of commands is displayed at the top of the screen. These commands serve as memory joggers for system-building commands, such as Control-L. To provide more working space on the screen, the list of commands can be removed and later replaced at any time. The commands displayed at any one time are limited to those representing options you would logically select, thus resulting in an uncluttered screen.

The more mundane commands, such as those for moving the cursor around the screen, are not given such prominence. Instead, if the user forgets how to perform a routine function, a Help key (either a Control command or a function key) invokes a full-screen display of helpful information. Starburst ensures that the screen display does not overwhelm the user with a list of too many commands from which to choose. Photo 2 shows a typical Starburst Help screen.

Starburst also addresses another commonly ignored area of the screen interface: placement of information on the screen. A video display is generally thought of as a page that users read from left to right, top to bottom. Depending on what is being sought, however, their eyes jump around the screen in different patterns, and Starburst is designed with those patterns in mind. Its Help commands, for instance, are listed in the

ASK for *variable* with *text*
CHECK for *file*
CLEAR screen
COPY *source* to *destination*
DELETE *file*
DISPLAY *text*
EXIT (to terminate processing)
LIST (to display each statement before execution)
MOUNT disk *name* on drive *name* (to be sure the proper disks are in the proper drives)
NOLIST (to turn off the LIST function)
PAUSE
PROMPT *text*
REMARK (to document the code being written)
RENAME *old file* as *new file*
RESET (for CP/M disk resets)
RUN (to begin execution of program other than Starburst)
SET default drive to *name*
SETSBCODE *integer* (to directly change the system variable)
IF *condition* then (to execute some commands only when the condition is true)
ELSE (to specify an alternative set of commands to be executed when the condition in the IF statement is not true)
ENDIF (to mark the end of the IF...ELSE construction)
REPEAT (to begin a repeated loop)
STOPREPEAT (to skip to the end of the loop)
ENDREPEAT (marks the end of the loop)

Table 1: *These 24 action statements can be strung together to perform almost all system functions.*

bottom right-hand corner of the screen, where research suggests a users' eyes will travel when they are in trouble. Building (creative) commands are positioned in the center of the top portion of the screen. This scheme is supported throughout the program.

A Natural Language

As mentioned earlier, you use 24 Starburst task statements to control the execution of a system operation. Stringing these statements together actually constitutes high-level program coding. Starburst also includes many features to aid the inexperienced programmer and to help the seasoned coder to stay out of reference manuals, concentrating instead on building the system.

The screen interface for specifying these statements is designed for speed and ease of use. Photo 3 provides an example. The keyword, or first word, of each statement is displayed in the command list at the top of the screen. If you have trouble remembering the use for a particular statement, you can type the keyword, press a function key, and a detailed message appears at the top of the screen. If you only need to know the syntax of a statement, you can press another function key and a template is written on the line where the cursor is positioned. From that point, all you have to do is fill in the statement's blanks.

The syntax of the statements is the most elemental part of this interface. See table 1 for a list of the statements and an explanation of what each one does.

The conditional logic (IF...ELSE...ENDIF) is driven by the system variable, which can be altered in any of three ways. First, a SETSBCODE statement can assign a new value to the system variable directly. Second, the CHECK statement, which looks for a specific file on a specific drive, can return a new value for the system variable, depending on the result of the file search. This feature allows elegant recovery from an improperly configured system—the applications program will never be executed if Starburst detects a file out of place.

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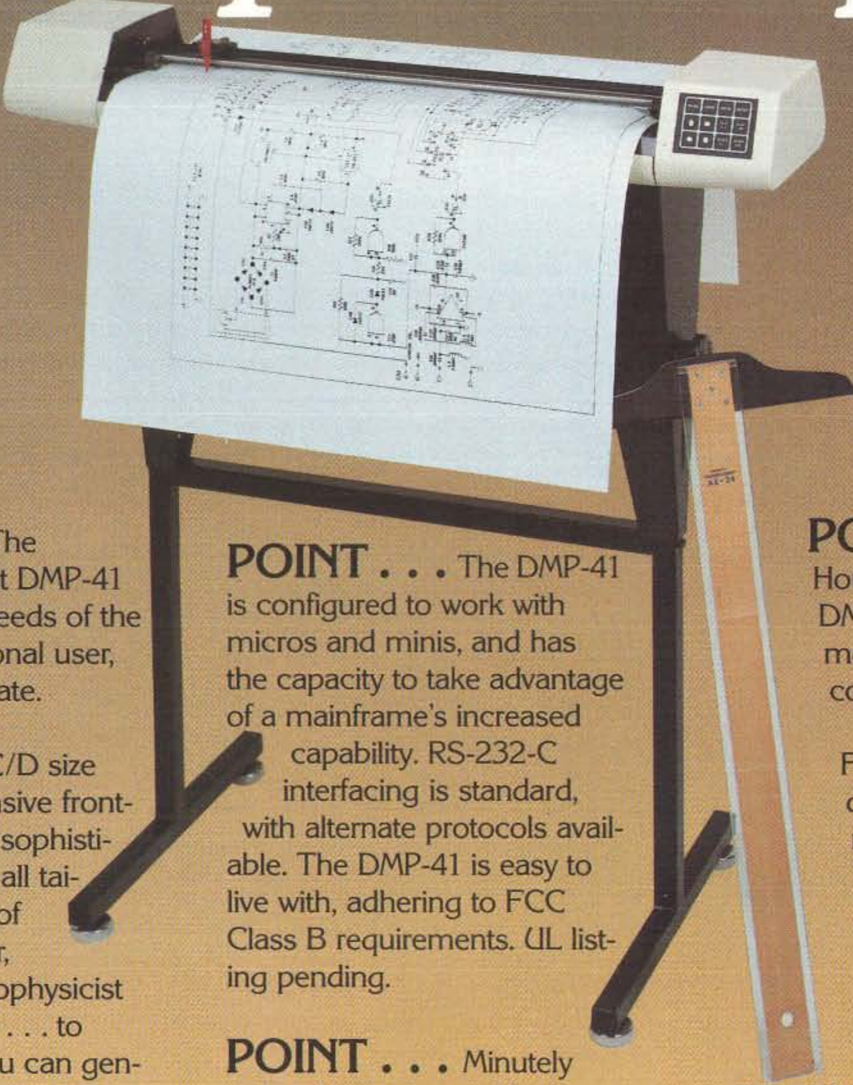

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Third, because the address in RAM where the system variable is stored is supplied in the documentation, you can write a program to be executed by Starburst (via a RUN statement) that will assign a new value as well.

Other variables, which have values assigned by direct operator response to ASK statements, are used, as are merge-print variables in a word-processing environment. A prompt displayed to the system operator asks for a value for one variable. The operator's response can then be plugged into other places in the list of statements. Here is a simple example:

The task begins with this statement:

> ASK for &MEMONAME& with prompt "To whom is this memo addressed?"

As a result of the preceding statement, the following text is displayed on the screen:

> "To whom is this memo addressed?"

The operator responds:

> "MARY"

Then, in all statements in the list that include a reference to the variable &MEMONAME&, the character string "MARY" is substituted. For example, the statement "RENAME TEMPLATE.MEM as &NAME&.MEM" would be rewritten automatically as "RENAME TEMPLATE.MEM as MARY.MEM."

The compiler for these statements is also a friendly programming aid. When you complete a set of commands, the compiler is automatically invoked to check the syntax and content of each. If it detects an error, the cursor is positioned at the offensive character. Correction can be aided through the Help functions described previously.

The Architecture of Starburst

The core of Starburst is the *resident*, a small section of code (about 12K bytes long) written in assembly language. It loads just above the operating system in RAM (random-access read/write memory) and monitors the progress of the application system.

The remainder of Starburst is written in the C language. The other significant module, the *transient*, is in control whenever a menu is displayed or when a system is being designed. The transient controls the execution of the task statements (e.g., variable assignment). When an applications program is run, the transient "goes away" and leaves only the resident in RAM, above which the applications program is loaded. When the applications program completes execution, the resident reloads the transient.

Starburst's architecture maximizes the limited RAM available on many 8-bit computers, while it allows the added RAM of the new generation of 16-bit machines to be fully used by the application. The transient functions like a super-overlay file. When a series of statements is about to be executed, a special action file is written on the disk, so that even in the absence of the transient, the resident has a reference for execution. This means that, effectively, Starburst occupies only 12K bytes of RAM.

Starburst helps eliminate some of the mystique of programming, the convoluted structures that confuse so many users. The idea behind Starburst is to soften the interface between the user and the system, especially for new users. To design a Starburst system effectively, you must be able to think logically or at least linearly. Most people in the business world are frightened or intimidated by computers and programming, and for them, Starburst helps clarify the elements of system programming.■

Steve Vandor is product manager of Micropro International Corporation (33 San Pablo Ave., San Rafael, CA 94903).

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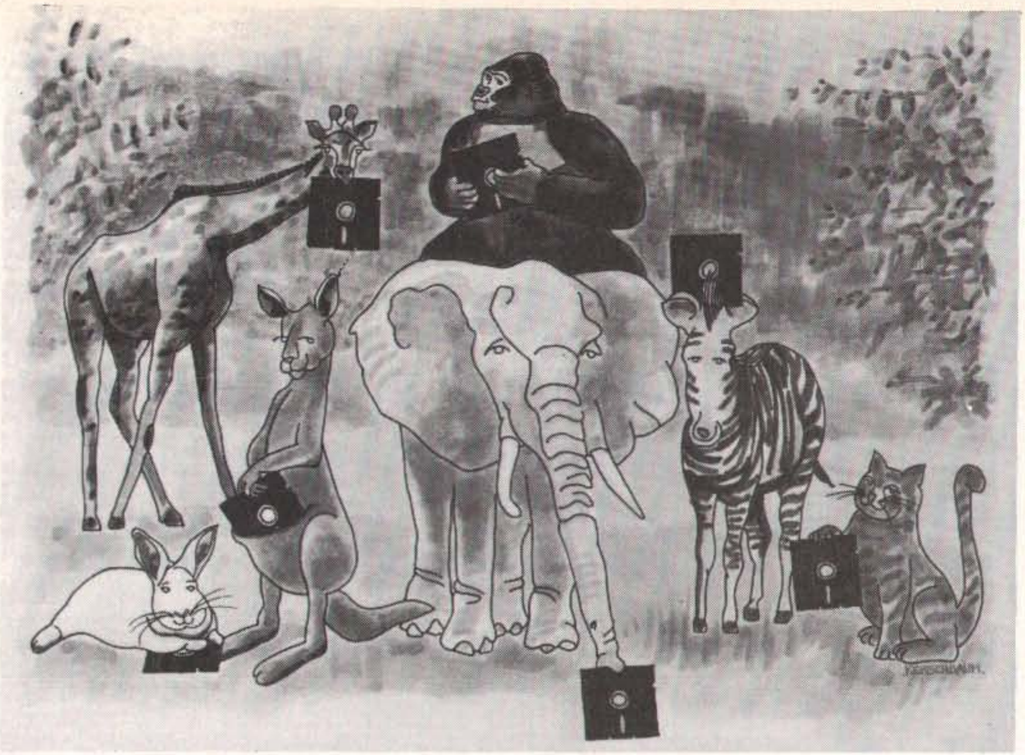

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——	——
——	——
——	——
——	——
MFD-11	2.09
——	——
——	——
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The Complete Information-Management System

Integrated software must satisfy human and machine requirements

by Michael J. Brown

While it is doubtful that a universally accepted definition has been penned, microcomputer users and software writers continue to search for the ideal, or total, information-management system. This integrated software package will utilize any special hardware features and minimize user interaction. It will be easy for the novice to use yet will have all the features and capabilities experienced users expect.

Information will pass effortlessly from one application program to the next, and user information will be stored, shared, and retrieved efficiently. Most important, though, is that integration will extend to provide complete project-processing capabilities; once a format is established, no other operator intervention will be necessary.

This article provides a brief history of software integration and lists the goals and requirements of one approach for a total information-management system. Also included are text boxes that discuss the data interchange dilemma and an actual integrated-system implementation.

Early Attempts at Integration

The earliest attempts at software integration made during the advent of the microcomputer industry simply explained the file structures of various application programs so programmers could write code that could access this data for custom applications. Examples of this include custom report writers, better known as form generators.

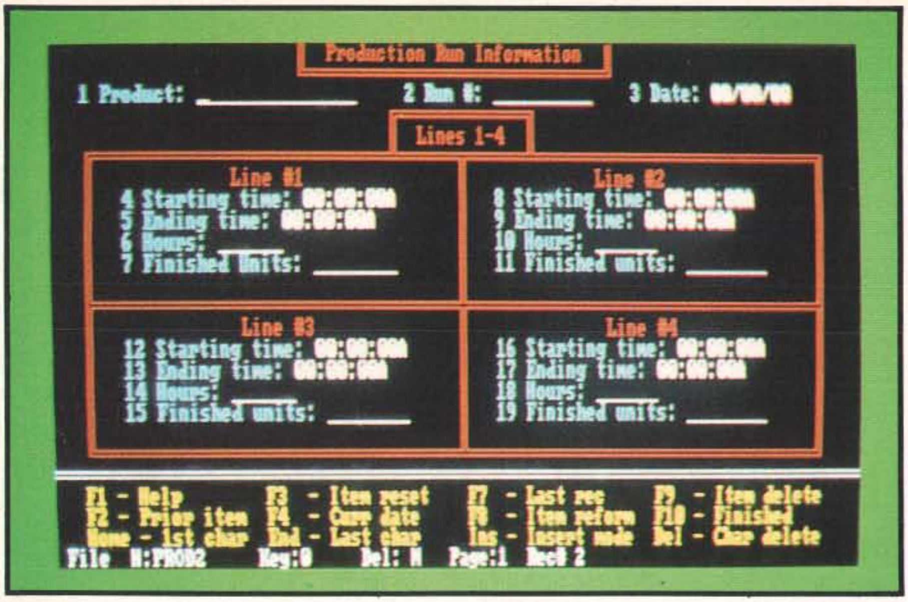
The second level of integration involved the so-called families of integrated products, such as the Supers, Perfects, Visis, and Stars. Unfortunately, integration seemed to be an afterthought and usually consisted of an intermediate file output and input capability. One program, a mailing-list record keeper, for example, could output its data (or a subset thereof) into an easy-to-use file structure. One of the more common configurations, though, was a standard ASCII (American National Standard Code for Information Interchange) file in which fields were delimited by commas and each record was terminated by a carriage return and line-feed character combination. Once a file was output in this fashion, another program—for example, a word processor—could read this ASCII file and use the contents to generate form letters, memos, and the like.

Total integration provides for complete project-processing capabilities.

Another example of this second level of integration was the DIF (Data Interchange Format) standard included in Visicalc. This was infinitely more useful to nontechnical computer users because programming was not required. Even so, this method was often cumbersome and required a significant understanding of files, fields, records, field delimiters, filenames, and extensions. Most important, this level of integration usually required user interaction on an operating system level. Thus, this second level was still too complex for neophytes and too constrained for technocrats.

The third level of integration was introduced and made famous by 1-2-3 from Lotus Development Corporation. No longer did you have to worry about ASCII or DIF files because spreadsheet capabilities and graphics shared the same file structure; no intermediary file interfacing was required. There can be some drawbacks when your information-management system requires database management in addition to spreadsheet and/or graphics programs.

Database management is a unique



```
                  Production Run Information
1 Product: ____________   2 Run #: ________   3 Date: 00/00/00
                          Lines 1-4
           Line #1                            Line #2
 4 Starting time: 00:00:00A         8 Starting time: 00:00:00A
 5 Ending time: 00:00:00A           9 Ending time: 00:00:00A
 6 Hours: ______                    10 Hours: ______
 7 Finished Units: ______           11 Finished units: ______
           Line #3                            Line #4
 12 Starting time: 00:00:00A        16 Starting time: 00:00:00A
 13 Ending time: 00:00:00A          17 Ending time: 00:00:00A
 14 Hours: ______                   18 Hours: ______
 15 Finished units: ______          19 Finished units: ______

F1 - Help         F3 - Item reset   F7 - Last rec      F9 - Item delete
F2 - Prior item   F4 - Curr date    F8 - Item reform   F10 - Finished
Home - 1st char   End - Last char   Ins - Insert mode  Del - Char delete
File B:PROD2     Key:0     Del: N    Page:1  Rec# 2
```

Photo 1: *Production-run information that is input and stored in a database record.*

and very important piece of the information-management system. A database manager should give you total control of your data from start to finish. Data validation should be done upon entry, and full selection and retrieval of specific subgroups of information are musts. Form and report generators should be full-featured to make output of stored and manipulated data simple. Large files as well as multiple-file interaction should be accommodated.

The Complete System

The complete information-management system consists of four parts: database management, electronic spreadsheet, graphics, and word processing. Most business and office information-management systems include all of these to some degree.

The database-management program becomes the starting point. All current information is entered into the user's database. This information might include sales or invoicing information as it occurs, and each time a transaction (such as a sale) occurs, the new information is entered and accumulated. A business manager then uses this information to generate sales and commission reports. Selected information can be summarized by salesmen and then used by the spreadsheet program to project future period sales. Past, present, and future information is compiled, summarized, and used for decisions. Graphics can be generated on screen or paper to make past, present, and future comparisons easier. Summarized information, graphs, and projections can then be included in end-of-period reports provided by the word-processing program. The word processor inserts these figures and graphs into a template report and surrounds them with text. From project start to finish, user intervention is not required. And because this project is done at regular intervals, the information-management system just repeats the report's last procedure to generate the next one. This is a good overview of a complete information-management system. The problem is coming up with a data structure that maximizes hardware and software efficiencies. A short discussion is provided in "The Data-Interchange Dilemma" text box on page 203.

The complete information-management system consists of a database manager, a spreadsheet, graphics, and a word processor.

System Components

We can divide our complete information-management system into four areas: ease of use, full-featured programs, integration and project-processing capabilities, and technical feature strength. "Ease of use" and "user-friendly" are perhaps the most overused and nebulous terms in the industry. Their importance as concepts cannot be underrated, however, because more and more computer neophytes are operating microcomputers. First, then, to be easy to use, software must offer help options throughout. No matter what is on the screen, a designated key will provide useful information. This might be accomplished by using two levels of help—the first an abbreviated explanation, and the second level a more in-depth explanation.

Second, both help and system features should be divided into confidence levels. When you are just starting to work with a system, complicated features should not even appear on the menu. As your familiarity and confidence increase, more features can be accessed, and you move from foundation commands and features to the program's intricacies a step at a time.

Third, users should be able to create custom menus for their own applications. This is particularly important because it coincides with the integration and project-processing capabilities explained later. Custom menus allow you to define and name projects and tasks. This way, novice computer operators are able to choose between "End of period processing" and "Select and send past-due letters" without ever having to know what a spreadsheet or database manager really is. Whole projects may be predefined and executed using custom menus.

The second area of the complete information-management system is that of full-featured programs. Each of the four main programs (database manager, spreadsheet, graphics, and word processor) should be able to stand alone as a competitive state-of-the-art program. When integrated with another or with the remaining three, the result is an even more

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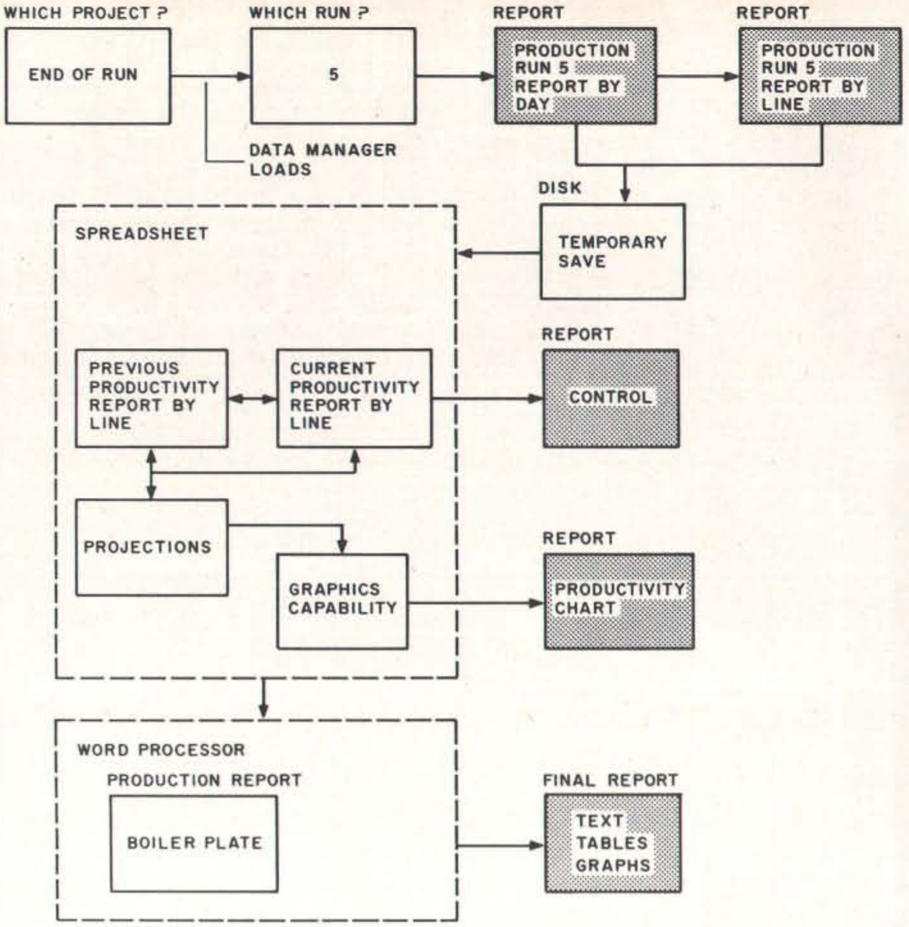

Figure 1: *Process sequence and reports generated by "End-of-run full project" described in text.*

powerful combination of features, the whole being a better system than just the sum of its parts. It is important to note that using only one or two of the four programs does not limit that program's capabilities. This also allows you to grow with the system as your needs and finances permit.

The third area is the key—the level of program integration and project-processing capabilities. Project processing is to all present information-management systems as a robot welding system is to a butane torch. Both get the job done, but both the butane torch and current integrated information-management systems require repetitive user intervention. Project processing is like the robot welding system. It may do a number of intricate tasks, in the order in which it was instructed, quickly and without outside intervention.

For instance, let's say your company manufactures six models of diesel generators. Each time you finish with a production run, a productivity report is required. As each day of the production run is completed, the hours and amount of materials are entered into the database as shown in photo 1. You can then begin the productivity report. You have defined custom menus like the one that follows:

Babcock Diesel Generators
Production Department
Project Menu

L = Production report line only
P = Production report by product only
E = End-of-run full project
G = Go home and sack out

so that inexperienced personnel can complete the project.

For this project, you choose the "End-of-run full project." The data manager is loaded and you are

The Data-Interchange Dilemma

by Mark Callegari and Brian O'Connor

The Problem

One man's heaven is another man's hell. This phrase correctly describes the problem of data interchange among various application programs. The crux of the problem is that each type of application requires a unique type of data structure to operate at maximum efficiency. Unfortunately, the more unique the data structures, the harder it is to exchange data. This is analogous to the problems of people with different abilities who must work together. For example, let's say you have programmers, engineers, accountants, and product managers who specialize in each of their respective areas. The problem occurs when a project requires the interaction of two or more of these groups. Although each person is competent in a given field, some proficiency in the other fields is needed for a successful project. If we substitute those workers' unique abilities for our program's unique data structures, we can see that the problem of information flow exists in both areas.

In a totally integrated system at least four different types of structures exist.

Database Structure

The data in a database can be broken down into fields, records, and files, and each component has its associated attributes. Fields have field length and field type associated with them. Records have record length, and files have various header information stored with them. These attributes are used to describe the data, and without them the raw data on the disk would be useless. Various other files are associated with a database that includes those used for key fields or subgroups of the database. As you can see, many interrelated components make up the actual data in a database.

Spreadsheet Structure

A spreadsheet's structure is quite a bit different than that of a database. Here, each individual cell has one or more associated attributes. These describe whether the cell is calculated or contains data, whether it is alphanumeric or numeric, how many digits of precision to use, whether a dollar sign or percent sign is to be used, and so on. The database, on the other hand, has attributes associated only with an entire group of cells, which are fields.

Word Processor Structure

A word processor's structure is more complex than either a database or a spreadsheet. Here, we no longer have repeating groups like records in a database or rows and columns in a spreadsheet. A document created by a word processor is divided into three basic components: the character, the paragraph, and the document itself. On the new generation of word processors, each character has an associated font, size, and position (subscript or superscript). Each paragraph has associated margins, spacing, and justification. And, finally, the entire document has associated page controls, header and footer information, and page-size information.

A word processor also must be able to integrate two foreign types of data. These include graphic files for embedding images in a document and ASCII (American National Standard Code for Information Interchange) files for merging data from other programs for form-letter and other similar applications. The more difficult of these two is the graphic file. Because a graphic image can be any size and appear anywhere in the document, the program must perform certain transformations to ensure that the image is legible. Printing the graph is not necessarily difficult since the whole document must be printed as a graphic image anyway. This is the only way to change the font and size of the characters.

Graphics Structure

There are several ways to exchange graphic information, including using a bit map of the image and using a graphics language to recreate the image. The simpler of these two is the bit-map representation. Using this technique, a series of bits makes up the image, with each pixel (picture element) consisting of one or more bits. If one bit is used for every pixel, then you can make that pixel either on or off. If you use two or more bits for each pixel, then you can either associate a color or a gray scale with each pixel. A typical graphic image consists of 640 pixels per line by 200 pixels per row. This method is the easiest to reproduce, but it takes up great amounts of storage space; the preceding example requires 16K bytes of storage. If we increase resolution to 1024 by 1024, our storage requirements will be almost 132K bytes.

An alternative to bit mapping is a graphics language. Here, you use a series of commands to recreate the graphic images as they are translated. This shrinks file sizes for high-density images but increases processing time and code requirements.

Diverse Data-Structure Problems

As we have seen, a wide range of data structures need to somehow be communicated if we are to have an integrated system. One way is to try to use one structure for several applications. Lotus chose this method when designing 1-2-3. The company designed a spreadsheet and added a database manager that uses the spreadsheet's structure. This simplifies writing the program but limits the database's specifications to those of the spreadsheet. Using our original analogy, this might be compared to giving an engineer's job to an accountant. Although the accountant could interact easily with the accounting department, his engineering skills would be limited.

Innovative Software has chosen to handle integration by enabling each application to use a structure that is most natural to it. Specialization of resources is as important in software as in manufacturing. If you are striving for maximum efficiency, each piece of the integrated system must be able to use data structures that suit the intended functions. This has several major advantages. First, it maximizes the speed of each application. Second, it maximizes the storage efficiency of each application. Lastly, it isolates each application from another.

But there are some drawbacks to this type of integration. It increases the complexity of program design, and there is a possibility that the program will be more complicated to use. Both of these objections are up to the program designer to solve. If they can be solved, the user gets the best program available. ■

Mark Callegari is vice-president of Innovative Software Inc. (9300 West 110 St., Suite 380, Overland Park, KS 66210). He holds degrees in management and computer science from Rockhurst College, and his interests include radio-controlled helicopters, karate, and computers.

Brian O'Connor is director of programming at Innovative Software. He has a B.S. degree in computer science from Rockhurst College and is interested in playing softball, the guitar, and gourmet chef.

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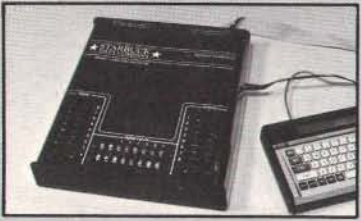

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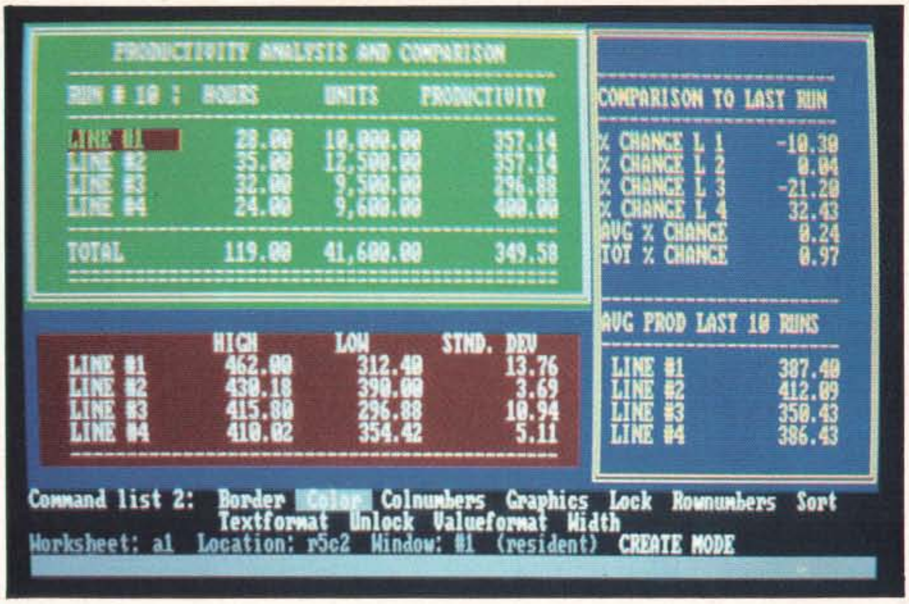


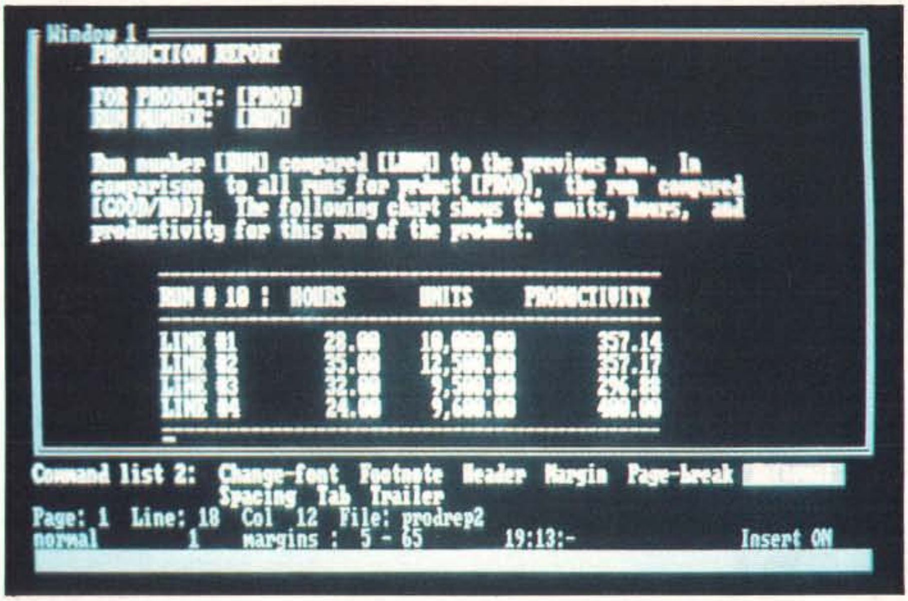
```
PRODUCTIVITY ANALYSIS AND COMPARISON
------------------------------------------------------
RUN # 10 :  HOURS      UNITS      PRODUCTIVITY
------------------------------------------------------
LINE #1     28.00   10,000.00        357.14
LINE #2     35.00   12,500.00        357.14
LINE #3     32.00    9,500.00        296.88
LINE #4     24.00    9,600.00        400.00
------------------------------------------------------
TOTAL      119.00   41,600.00        349.58
------------------------------------------------------

             HIGH        LOW     STND. DEV
LINE #1     462.00     312.40       13.76
LINE #2     430.18     390.00        3.69
LINE #3     415.80     296.88       10.94
LINE #4     410.02     354.42        5.11
------------------------------------------------------

COMPARISON TO LAST RUN
---------------------------
% CHANGE L 1        -10.30
% CHANGE L 2          0.04
% CHANGE L 3        -21.20
% CHANGE L 4         32.43
AVG % CHANGE          0.24
TOT % CHANGE          0.97
---------------------------
AVG PROD LAST 10 RUNS
---------------------------
 LINE #1            387.40
 LINE #2            412.09
 LINE #3            350.43
 LINE #4            386.43

Command list 2:  Border  Color  Colnumbers  Graphics  Lock  Rownumbers  Sort
                 Textformat  Unlock  Valueformat  Width
Worksheet: a1  Location: r5c2  Window: #1  (resident)  CREATE MODE
```

Photo 2: *Summarized production information extracted from the database and used by the spreadsheet for comparisons and projections.*



```
Window 1
    PRODUCTION REPORT

    FOR PRODUCT: [PROD]
    RUN NUMBER:  [RUN]

    Run number [RUN] compared [illegible] to the previous run.  In
    comparison  to all runs for product [PROD],  the run  compared
    [GOOD/BAD].  The following chart shows the units, hours,  and
    productivity for this run of the product.

          ------------------------------------------------
          RUN # 10 :  HOURS      UNITS     PRODUCTIVITY
          ------------------------------------------------
          LINE #1     28.00   10,000.00       357.14
          LINE #2     35.00   12,500.00       357.17
          LINE #3     32.00    9,500.00       296.88
          LINE #4     24.00    9,600.00       400.00
          ------------------------------------------------
          _
Command list 2:  Change-font  Footnote  Header  Margin  Page-break
                 Spacing  Tab  Trailer
Page: 1  Line: 18  Col  12  File: prodrep2
normal         1    margins :  5 - 65        19:13:-               Insert ON
```

Photo 3: *An example of merge-print word processing; a portion of the production spreadsheet has been inserted within the text of this production report.*

prompted for which run number you wish to get the reports on. The data manager automatically selects the information you request from an entire database of daily product/run records. This information generates a tabular production report by day. When finished, the run information is summarized by production line and another report is generated. This information is held temporarily on disk, and the spreadsheet automatically reads the temporary spreadsheet form. The spreadsheet begins your productivity analysis by line and outputs a control report. These figures are compared with the last run's productivity figures, and projections are made based on the differential. These figures are printed in a control report. Project flow is illustrated in photo 1. A portion of this spreadsheet is shown in photo 2.

The spreadsheet now calls the graphic function, and productivity charts are generated (photo 3).

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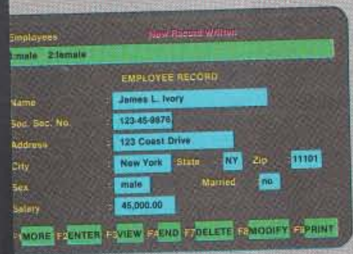

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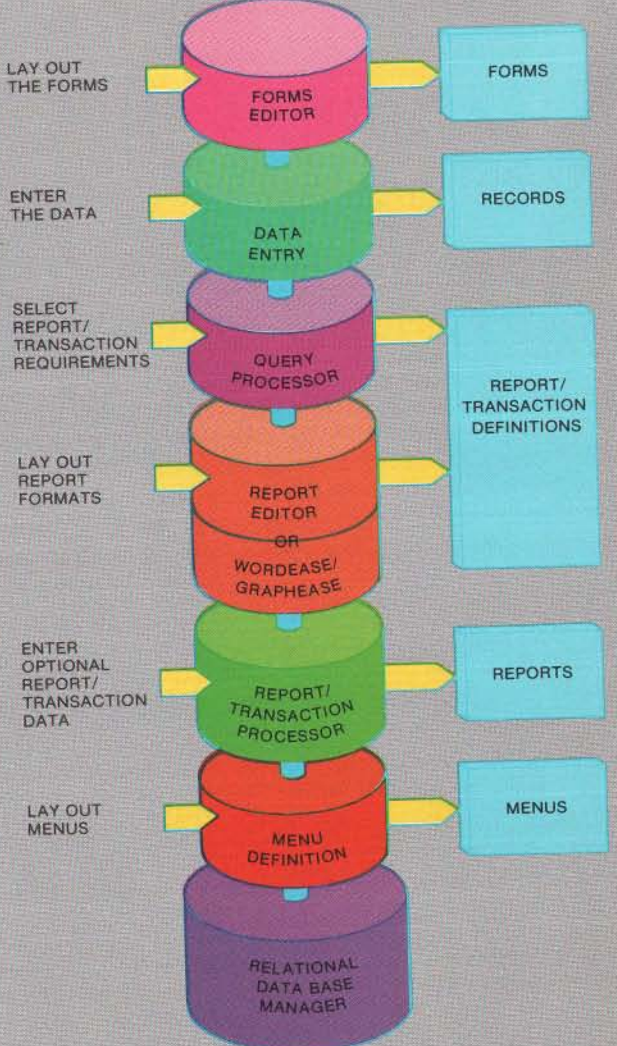

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An Integrated System Implementation

Innovative Software believes that the system should take advantage of current technology, so it provides for use of an optional 8087 arithmetic processor, a mouse, and large amounts of RAM. Additionally, it employs multiple windowing and full project-execution capability. The 8087 chip is extremely handy in the spreadsheet and database where large amounts of numerical processing take place. The mouse speeds editing of both the word processor and spreadsheet. As only a small number of programs presently take advantage of the large RAM-addressing capabilities of the 8086/8088, Innovative's system uses the large amounts of RAM that are being sold in current systems. Windowing allows several files to be seen and edited on the screen at the same time, or one file can be viewed from several different perspectives.

Project execution is the ability of one program to execute a series of tasks and then transfer control to another program to continue executing more tasks. As each task is completed, the project executor determines whether any errors have occurred, provides error messages if required, and continues with the next task. The project executor can transfer control among various sections of one application or to a completely different application program.

The language we used is C; portability and code efficiency dictated this choice. Where even higher efficiency and speed are needed, we used assembly language. Because of these choices, the system is very fast and is easily ported to other machines.

The total system consists of four basic parts: a database, spreadsheet graphics, word processing, and system utilities. These will be explored individually.

The Database

The database is the key component of the entire system. It must be very powerful to handle the full complement of business needs. Our database includes the following specifications:

1) *255 fields per record*
2) *12 field types with range checking and validation*
3) *Multiple screen layouts for each file*
4) *Over 100,000 records per file*
5) *Compaction of data on the disk*
6) *B-tree organization of key fields*
7) *Multilevel password protection*
8) *Complex equations, including IF-THEN-ELSE structures*
9) *Windows allowing multiple files on the screen*
10) *Project-execution capability*
11) *Custom programming language*
12) *User-definable menus*

We feel that these specifications make our system more than adequate to handle most business applications. The underlying data structure consists of a file containing variable-length records with an index file pointing to each record. When records are added, the program checks to see if there is any open space in the file. If not, records are concatenated to the end of the file. If a record is updated, the program first checks to see if there is room to write the updated record in the old space. If not, the updated record is placed at the end of the file and the empty space is made available for later use.

B-trees are used for key-field organization, although a sort/merge utility is available for temporary organizations. B-trees enable the program to insert new or updated data or find old data very quickly.

The calculated fields use the same basic parser that is in the spreadsheet. This gives the program the ability to do conditional lookups (IF-THEN-ELSE, CASE, SELECT, etc.), transcendental functions (sine, cosine, etc.), business functions such as NPV (net present value) and IRR (internal rate of return), as well as many other standard functions such as ROUND, INTEGER, etc. Selection of records for reports, lists, or forms can use the same basic parser using the AND, OR, and NOT operators combined with parentheses.

The program output can be directed to the form generator, the report generator, or the list generator. The form generator enables you to place fields anywhere on the screen, optionally include titles, read from multiple files, do conditional page breaks, calculate new fields, and put text anywhere on the page. You can create custom forms or print on existing forms such as invoices. The Report and List commands are really preprocessors to the form generator, eliminating much of the overhead associated with designing standard layouts.

The database accepts many types of files into its internal data structure. As a result, you can transfer data from other programs without having to rekey large amounts of data.

The Spreadsheet

Designing a spreadsheet becomes more art than science. A spreadsheet must handle large amounts of data in many different formats while performing many different commands. In addition to the standard features found in most packages, our spreadsheet contains the following features: multiple windows, built-in command language, interrelation of multiple spreadsheets, project-execution capability, context-sensitive help, and an efficient "sparse-matrix" data structure.

Perhaps the most interesting feature of the spreadsheet is the sparse-matrix data structure. In most spreadsheets, data space

The figures and the associated chart are saved for integration with the word processor. The word processor is automatically loaded, and the tables of figures and productivity graph are neatly inserted into the proper pieces of the boiler-plate production report and printed on a high-quality printer.

This is what project processing is all about. Starting with accumulated information in the database manager, information is summarized, printed, projected, graphed, and included in word-processing documents without any additional intermediary user interplay.

The last area in the total information-management system incorporates technical features such as powerful arithmetic capabilities for spreadsheet number crunching, summarizations in the database, and graph generation. The system should also take advantage of large amounts of inexpensive RAM (random-access read/write memory). Additionally, individual systems' screen and technical specialties should be exploited. The most efficient and quick data structures should be used for each individual program. Examples include B-trees for the database and sparse-matrix structures for the spreadsheet. Lastly, the entire system should be operating-system transportable.

The Innovative Software System

Innovative Software's complete

is allocated for each cell even if it is empty. Therefore, if you put a number in row 50, column 10, the program allocates 500 cells worth of memory. This is a waste if you consider that on a large model many cells are left blank to make things more readable. The sparse-matrix type of data structure eliminates this problem by using only as much space as needed—at the expense of program design complexity. In the sparse-matrix technique, swapping two rows in a work sheet is no longer a matter of swapping two blocks of memory. On large work sheets the memory savings is especially worth the effort. You can typically have work sheets two to five times larger than programs that simply allocate blocks of memory.

The graphics capability is built into the spreadsheet program. It also can be called during project execution. Some of the features included are three-dimensional bar and pie charts, multiple fonts, histograms, and a slide-show capability.

The Word Processor

The word processor is the most unique program of the system. It contains many features found only in dedicated word processors. Some of the features include:

- *Attributes shown on screen (underline, bold, etc.)*
- *Multiple windows*
- *Multiple fonts and sizes*
- *Flying reform*
- *On-screen math capabilities*
- *Ability to include graphics in a document*
- *Project-execution capability*
- *Context-sensitive help*

Each character is stored as a 2-byte integer. The lower 7 bits of the integer are used to store the character. The upper 9 bits are used to store the character's attribute, font, size, and other pertinent information. When you move a character, the font and size follow it to its new location. If you do not have graphics capabilities, you may optionally display the fonts using special character attributes such as color or intensity.

A graph from the graphics program can also be included in the document. A window in the text is defined in the document where the graph will appear at print time. During printing, the word processor reads a plot file saved from the graphics program and recreates the picture to fit the size of the window. This plot file contains all the information to recreate the picture, including different fonts, colors, and shapes.

Flying reform is the process of keeping a document always formatted the way you have defined it. Many word processors have a manual Reform key to clean up a paragraph after you have made insertions and deletions. The flying reform does this job for you. Every time you insert or delete a letter, the paragraph stays formatted.

System Utilities

The system utilities contain many useful commands. For example, a calculator utility handles either standard or RPN (reverse Polish notation) data entry. It handles equations with embedded parentheses up to 255 characters long with full cursor editing. It also contains three memory locations and can output answers in binary, hexadecimal, and octal as well as decimal.

Other system utilities include file-directory, file-copy, file-rename, file-delete, and other operating-system commands.

information-management system consists of the three previously mentioned products: a database manager, a spreadsheet/graphics product, and a word processor. All three have a built-in command or task processor that will allow a series of tasks to be done in series without user intervention. If two or more parts of the system are used, these command processors can initiate sequences of commands from the other command processor(s) allowing truly integrated project processing. For details, see "An Integrated System Implementation" text box on page 206.■

Author's Note:

Research in the areas of data structures, integration, and project processing was done by Roger Schroff, University of Southern Maine.

Michael J. Brown is president of Innovative Software (9300 West 110 St., Suite 380, Overland Park, KS 66210).

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The Allegory of Software

Beyond, behind, and beneath the electronic desk

by Tom Houston

People, like computers, process information, using languages to encode and communicate the meanings of things. In our speech and in our ideas about the world, we are the inheritors of cultural traditions whose continuity can be traced backward to prehistory. For a few human endeavors, such as hunting or food preparation, the antiquity of our ideas and symbols is no handicap, because we do some things in pretty much the same way as our ancestors.

We do other things that they never dreamed of, but in our habits of thought and language we prefer to reuse old terms, coining new words only as a last resort. A diesel vehicle might be "driven" by a "teamster," though no nosebag of oats awaits his horsepower. He is directed in traffic by left- and right-pointing "arrows," though today only aborigines and anthropologists make stone projectile points. Most English words have more than one meaning, because there are more things than words. Recycling old symbols to denote new things reduces the need to learn new words, enabling people to get by with small active vocabularies. Most new meanings are acquired through analogy: some similarity is asserted between an established meaning of a word and a new notion that needs to be given a name.

In the very broadest sense, computers do the same thing that other tools like arrows and diesel engines do: they amplify the power of our fingers. But computers do things in ways so different that analogies with older technologies are often not at all obvious. Proof of this is that the first few decades of the age of computers produced far more neologisms—previously nonexistent words such as "byte," "software," and "multiuser"—than other arts like arrow making or truck driving had required in their longer histories.

This concerned no one when a computer cost many times the price of a truck. In those days the few people who had to interact with computers tended to be an intellectual elite, people with big vocabularies who were comfortable with what laymen rightly regarded as esoteric terminology.

Suddenly, in the late 1970s, everything began to change, so that today the situation is reversed: the average truck costs many times the price of the average computer. Truck drivers, their spouses, children, and other people take smaller vocabularies to the computer console. The word "friendly" has a new, bitterly antitechnical meaning, and manufacturers and software publishers who hope to lead in the computerization of the home and workplace hasten to translate the special vocabulary of data processing into the vernacular.

This is an admirable, democratic, and perhaps profitable undertaking, but as with other matters that affect our life and culture, anything worth doing is worth doing right. One natural alternative to the engineering jargon and acronyms of the past is the use of metaphor; the unfamiliar procedures and tools of information processing are mapped onto an activity that is already familiar to the user. Are some systems of metaphor or analogy superior to others? Certainly yes, if by "superior" we mean a choice of symbolism that speeds learning and makes it easier for the novice or scatterbrained user to remember how to use a computer in a way that increases his or her productivity. Consider the "electronic desk" metaphor of Apple's Lisa: most people with Lisas know what a desk is and what people do at desks.

Are some systems of metaphor less suitable? Yes, and most are much worse. Infinities of mathematical isomorphisms can be used to map anything onto anything else. Computer operations, for example, closely parallel certain metabolic processes of the giant squid, but this is an unhelpful metaphor for people unfamiliar with giant squids (see figure 1). In contrast, the legend on a light switch ("ON," "OFF") describes the two states of a circuit breaker in terms of a spatial metaphor that Beowulf could have quickly grasped, had he been able to read.

Yet there is something disquieting about Lisa's desk metaphor. If the computer is going to revolutionize the white-collar workstation, then the primitive desk described by the Lisa screen icons may soon be unrecognizable to business users. Fortunately, other metaphors are available that the poets and marketing types responsible for maintaining computer symbolism might find more useful, symbols drawn from fixed and unchanging aspects of our lives and culture. Several of these are proposed below.

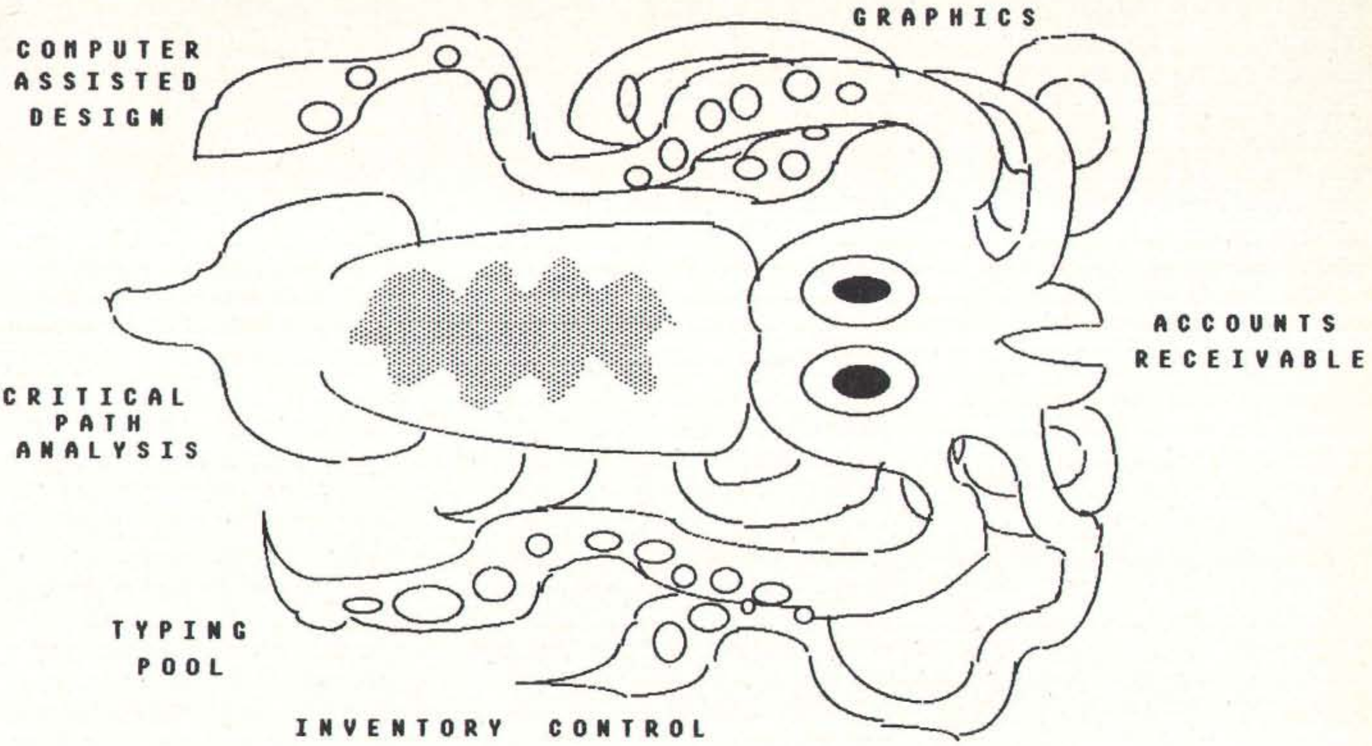

Figure 1: *The inappropriate giant-squid metaphor.*

Everyone who eats will appreciate the universal symbolism of the **Digital Kitchen,** based upon the striking similarities between information processing and food processing. Here the Refrigerator icon accesses removable disk storage, and the Freezer sends files to and from the hard disk. Selecting the Recipe Book icon provides Help files, and each of the six Burner symbols on the Stove offers a different delicious way of cooking one's data—word processing, spreadsheet, inventory control, database management, statistical package, and report generator, each coded with a different on-screen color and by the olfactory signals of an Aroma Synthesizer.

The little Telephone icon provides modem communications, and the Open Window activates the network controller for access to neighboring systems. Graphics work is accomplished through the Cake Decorating Kit icon, and various system utilities are accessed through the Spice Rack. Floppy disks are formatted by selecting the Dish Washer, and the little Garbage Disposal symbol gives the erase command. The Flyswatter loads a debugging tool, and the Oven symbolizes compiler and interpreters—what language is indicated mnemonically by the type of cuisine selected (American for BASIC, Chinese for COBOL, French for FORTRAN, Italian for Interpreted BASIC, etc.).

The Digital Kitchen analogizes information processing and food processing.

For dual processor systems, the "COLD" and "HOT" faucets of the Kitchen Sink icon choose between 8-bit and 16-bit CPUs. A Potholder is used to direct the cursor to any of the above symbols. Note that this iconography avoids nontraditional kitchen items such as trash compactors, smoke detectors, bacon flatteners, and electric can openers, which might become obsolete or may not yet be familiar to some users outside the United States.

Some may regard the system of metaphors given above as excessively domestic and inconsistent with the prestige and power of an executive console. In recognition of the fact that many hard-hitting businesspersons rarely go home, we propose as an alternative the **Electronic Cocktail Lounge.** Rather than clutter the screen with gadgets whose real-world functions top-level executives leave to their staff, this system of symbols depicts a bar in which each software function is personified by icons of a Waitress (the Help menu), a Bartender (operating-system commands), and various Patrons.

The Patrons represent the applications programs available to the user: a Bookkeeper, with a distinctive green eyeshade, represents accounting software; a Bookmaker, with a loud tie, signifies spreadsheets; an efficient Secretary selects word processing; an exotic foreign Linguist stands for programming languages; an Artist, in beret and smock, does graphics work; a Security Officer, in full uniform, puts passwords on files and devices; a burly Warehouseman handles mass storage; a prim Librarian performs archival functions; a Middle Manager, in a three-piece suit, stands ready to provide database management; and a friendly Bouncer will 86 unwanted files. The cursor is directed with a Swizzle Stick. Less expensive systems would offer more sparsely populated Lounges, typically with a seedier clientele and no happy hour.

One difference between Lisa's electronic desk and an ordinary desk is that you can only hide a bottle inside a real drawer, but this Cocktail Lounge symbolism is likely to offend users who agree that alcohol poisoning is among the dominant factors in Western history. Less controversial is a different metaphor, which depicts more realistically how work gets done in a real office. Called the **Electronic Secretary,** it provides a number of unique capabilities, such as purchasing thoughtful gifts for the user's loved ones on anniversaries and birthdays and using its voice synthesizer to provide convincing misinformation on the user's whereabouts, via modem, to incoming calls from persons listed in the IMNOTIN file. Its screen is not illustrated here because, apart from the cursor, it uses icons very similar to those of the Lisa. ("Why reinvent the desk?" a spokesman asked rhetorically at the Lisa Imitation, Simulation, and Emulation (LISE) trade show in Kowloon last year.)

For vertical markets, the **Electronic Elevator** is an almost ideal image in terms of its familiarity to office workers, its established design, and the ease of drawing the array of circular icons. Here each Floor represents an applications program, so the user only needs to know where to get off. The Buttons representing each floor are selected by moving a cursor, which is imaginatively shaped like a finger.

Before desktop computers, CRTs were primarily instruments of escapist entertainment, and this traditional association can be exploited by software imagery to dramatize the Adventure of Data Processing (ADP). The icons create an **Electronic Jungle,** symbolizing the salient features of a typical business environment. The configurable cursor can be in the form of an Explorer, Adventuress, Apeman, Tribesman, or Field Representative, selectable by the user. The dense Foliage (paperwork) can be cleared away by the Machete (word processor), by Fire (the erase command), or by the other members of the Safari (electronic mail). Behind some of the bushes lurk dangerous Beasts (data files and creditors), who can be subdued by specialized software tools such as Cages (mass storage), Nets (spreadsheets), and Firearms (database-management software). To "bring 'em back alive," your Backpack (directory) has Cameras (graphics packages) and Tranquilizing Darts (report generators). A Witch Doctor version is available for medical applications.

A few readers may object that some of the metaphors proposed here are not worth implementing because the actual resemblance between the icons and the software functions that they symbolize is farfetched, arbitrary, obscure, ludicrous, or counterintuitive. Opinions of this sort reveal a literal-mindedness that should delight in the **Electronic Electronic Computer** (or EEC, as these are called in Europe). The on-screen image depicts a little Computer, complete with Keyboard, Screen, Disk Drives, Software, and Technical Manuals. The Cursor, controlled by a "bug," is in the form of a cursor. By using this to press the keys on the little Keyboard, programs can be invoked and systems commands given, just as on a real computer. Engineers, programmers, and other computer industry professionals who are already comfortable with pre-Lisa computers are more likely than neophytes to prefer this iconography. Systems capable of concurrency can have several EECs on the physical screen at once, each running a program as a virtual console. Pressing the Help key on the Keyboard of the little Computer icon will cause an even smaller Computer to appear on the screen of the Computer icon, with helpful messages on the Screen of the Screen within a Screen. Systems with finite RAM are typically incapable of infinite regress.

Although most readers of this magazine tend to view the proliferation of computers with equanimity or approval and accept the computerization of the office as beneficial, others fear or mistrust the new technology and imagine that things were better in the good old days. Traditionalists may prefer iconography based on the metaphor of the **Low-Tech Electronic Stone Age** (LESA), in which the cursor (called the Rock) is directed at targets representing different applications software functions. The Giant Parrot is a word processor; the Sabertooth Cat invokes accounting software; the Woolly Mammoth is a big spreadsheet; and the Cave provides both mass storage and walls on which graphics work can be performed. Figure 2 exhibits the Neanderthal version, set in a Pleistocene landscape. An Australopithecine version is designed for technological conservatives who absolutely dislike computers. The same icons appear as in the illustration, but instead of actually loading programs, their effect is to send gutteral commands to coworkers who rank lower in the primate horde. While all this may seem like a clumsy metaphor, it provides more reassurance than a mere desk to those who long for the bygone days when typewriters ruled the earth.

All of these metaphors compare the computer to things from the present or past. Because computers seem to have more of a future than we do, shouldn't we compare them to things to come? In a few years, when today's adolescents take their

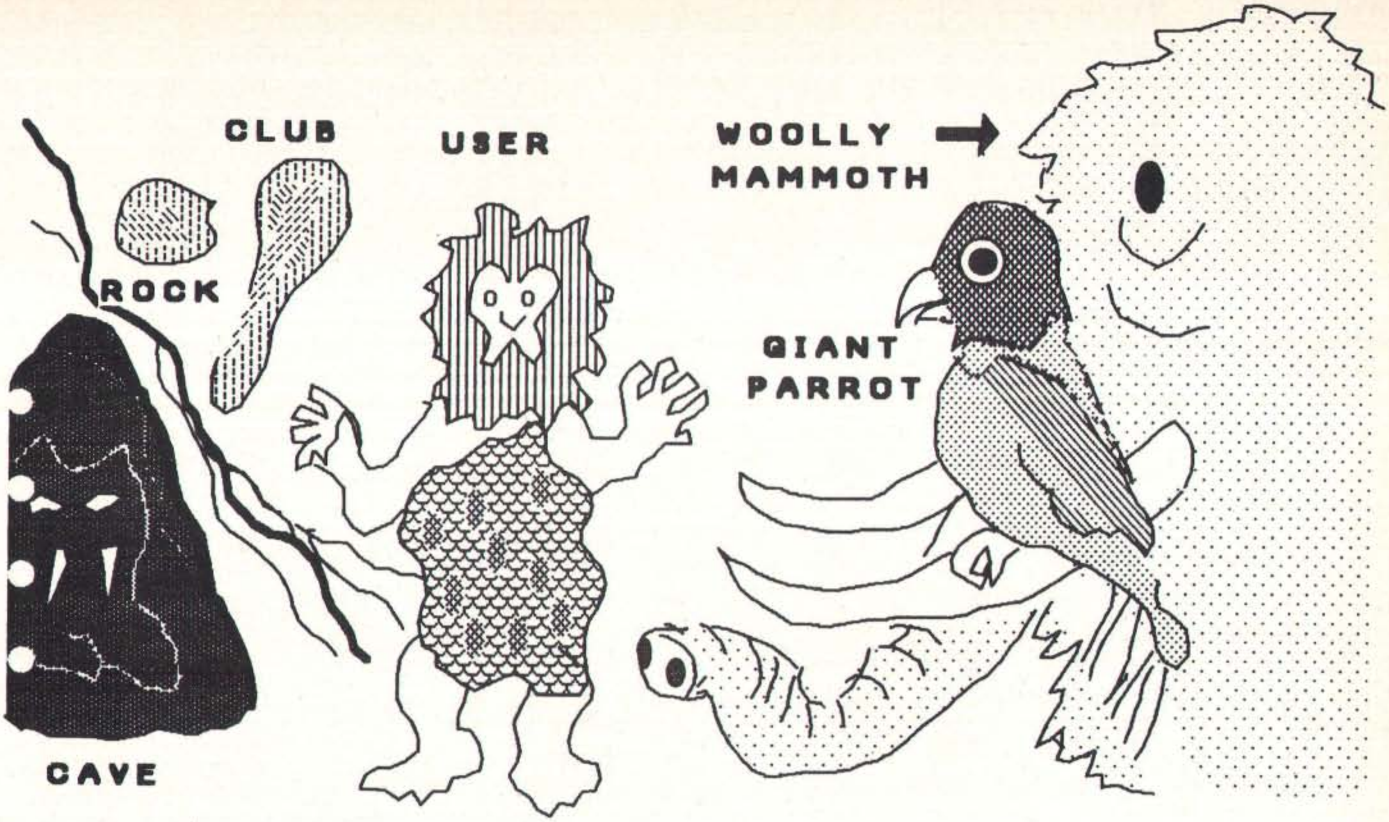

Figure 2: *The low-tech electronic stone-age icons.*

place in the office (or wherever they will work, if any of them ever get jobs), surely their arcade training will have prepared them not for the drawers and papers of our quaint desks, but for the joystick and fire button of a **Business Battlestation**, illustrated in Figure 3. The cursor is the crosshairs, and work tasks are shown as elements of the Enemy Fleet. After all, who would want to process data when it's more fun to blast it? This symbolism offers users a chance to use strategy, tactics, and advanced weapons against files and deadlines. This metaphor of combat may at first glance seem unbusinesslike, but it has long motivated lawyers, coaches, soldiers, cinema heroes, and other rugged individuals respected in our culture. With a high-performance spacecraft and an arsenal of Phraser Beams (word processors), Debt Rays (accounting modules), Time Warp (scheduling utilities), and the like, these futuristic systems will quickly recover their development costs through the quarters inserted by their users.

Naturally, rather sophisticated soft-

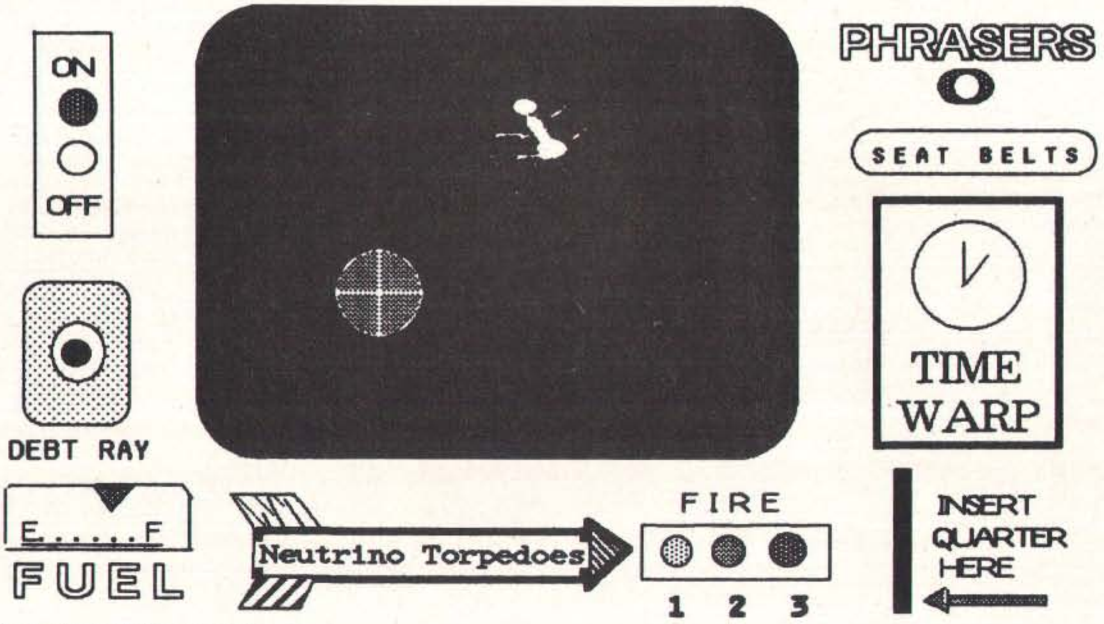

Figure 3: *The business battlestation icons.*

ware will be required that can usefully process information by "blasting" it, but this is not the place to go into the tedious coding details of next-generation "smart" programs that can be used by operators who have no idea of what they are doing. Suffice it to say that these advanced routines will identify the user's problems and destroy them. Powerful icon-driven software that combines both operating systems and applications program functions may require great effort to develop, even if the iconography is borrowed from existing video games.

Conclusion

In this postindustrial age, computer literacy is already linked to economic survival. Our society may have no choice but to reallocate the resources that are now devoted to outmoded institutions like our educational system and instead to develop software that will minimize the skills necessary to operate a computer. Like the small mammals that ultimately displaced the dinosaurs, Lisa's mouse and visual imagery may be the first step toward office systems whose keyboard will devolve into something more simplified, like a light-switch, and whose screen icon will invoke a single program so versatile and so omniscient that it will not matter whether the user can remember anything.

A "friendly" computer is easier to imagine than to describe, but friendliness clearly has something to do with substituting symbols drawn from natural language and ordinary life in place of technical terms in the dialogue between user and computer. One celebrated attempt to make an advanced computer friendly is found in the icon-driven integrated software of Apple's Lisa, based upon the metaphor of a desk. Because desks as we currently know them will soon exist only in antique shops and Lisa manuals, this article has proposed a number of alternative metaphors that seem less subject to obsolescence. These seem more suitable for incorporating into school curricula or imitating in Hong Kong because they are based upon unchanging and eternal things: the kitchen, the tavern, the cave, the computer, and the flying saucer.

Readers who currently have or who will soon have a Lisa can take advantage of any or all of these suggestions, at least regarding the names of the icons, because the Lisa software allows the user to replace the standard icon names with user-defined names, using the Lisa text-editing utility. If the metaphors recommended here or customized terms supplied by the user are substituted for the "electronic-desk" nomenclature, however, the printed manual provided by Apple may become less helpful. Readers who are currently developing integrated software packages for commercial distribution are invited to incorporate any or all of these suggestions into their iconography and documentation; we will regard as ample reward the satisfaction of advancing the state of the art, and a royalty fee that our lawyers can describe. ■

Tom Houston, Ph.D. (Gifford Computer Systems, POB 1917, San Leandro, CA 94577) is an educational psychologist and writer who has worked with small computers since 1976. Coauthor of the Gifford MP/M 8-16 User's Manual *and of the Compupro* Systems 816/A and 816/B User Guide, *he edits the* Gifford Observer, *a multiuser CP/M and S-100 newsletter.*

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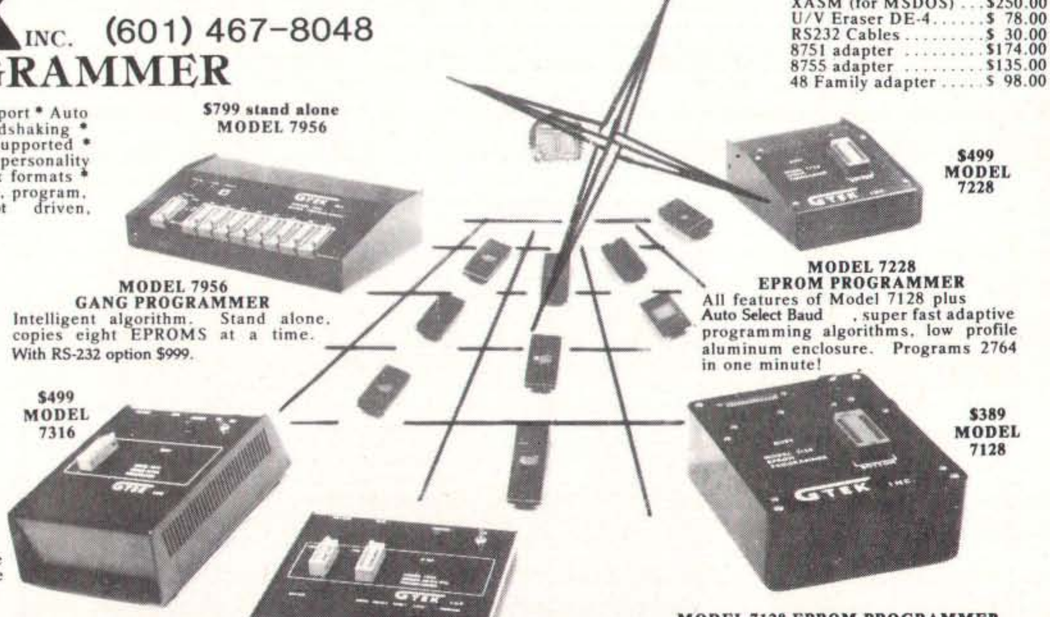

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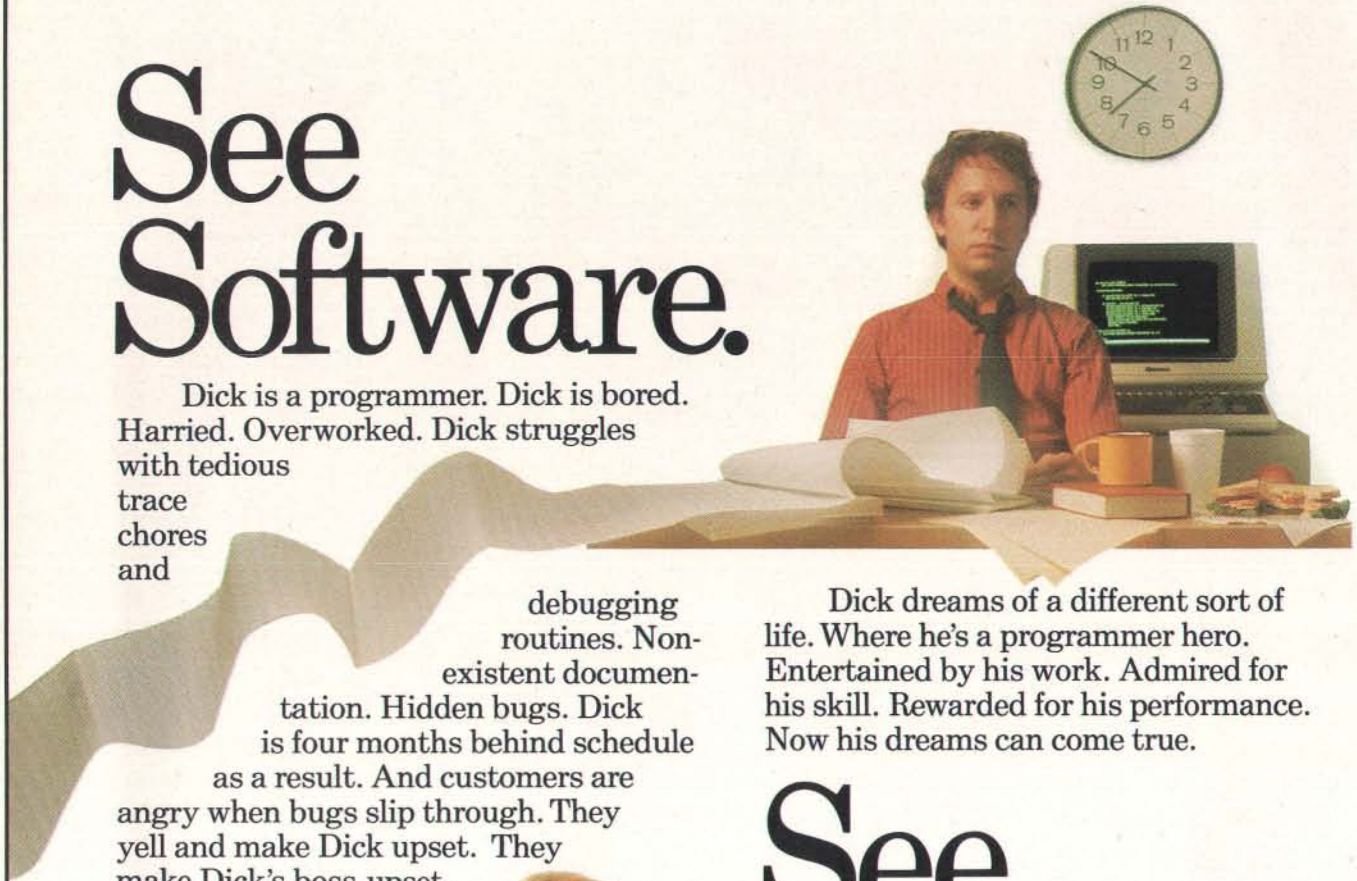

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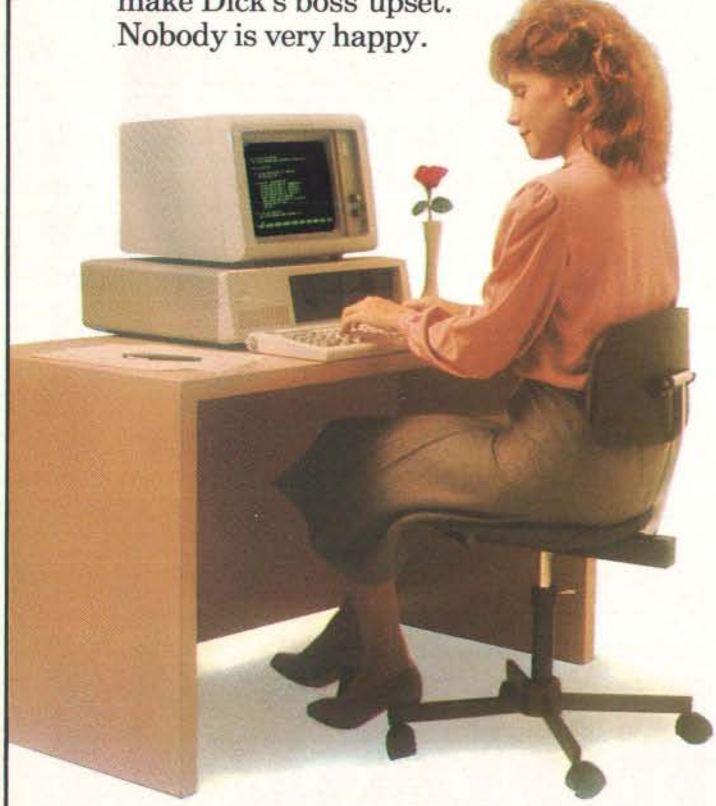

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The New Interface Technology

An Introduction to Windows and Mice

The new computer systems will be easier to use and more productive than their predecessors

by Robert W. Warfield

A new breed of personal computer hardware and software is beginning to enter the marketplace. These systems will be both easier to use and more productive than their predecessors. People who are not computer experts will feel comfortable using these personal computers in their day-to-day work, and experienced users will make fewer errors.

This "new interface technology" encompasses developments in hardware and software that essentially reduce the number of things a user must remember in order to use a system effectively. On the hardware side, pointing devices such as mice, touchscreens, and high-resolution graphics displays simplify communication between the user and the system. The software offers integration, multiple windows, and commands issued by selection from menus using the pointing devices. The combination of these features ensures that the users can concentrate on how people work instead of on how computers work.

Examples of the new technology currently or soon to be on the market include hardware/software combinations such as Apple's Lisa and Hewlett-Packard's 150 and software such as Visicorp's Visi On and Microsoft's Windows.

History

How did all of this new technology come about? Much of the work can be attributed to Xerox PARC (Palo Alto Research Center) and its Learning Research Group (LRG). But the seeds of the technology can be traced farther back to Douglas Englebart's work on using computers to augment human intelligence (reference 2). It was Englebart's group that first invented the now-familiar mouse and incorporated multiple windows into the design of text editors. Englebart's work is discussed in Ted Nelson's excellent book, *Computer Lib/Dream Machines* (Nelson is another visionary who has been discussing the new interface technology since long before it was a reality on any computer).

The work at Xerox PARC began in 1971, when Alan Kay founded the Learning Research Group and initiated a project called Dynabook (reference 3). Dynabook was to have been a notebook-sized personal computer that anyone, even children, could use in day-to-day work and that everyone would want to use. The Xerox Alto personal computer (refer-

Video Pointing Devices: Enter the Touch Tablet

Popular video pointing devices include mice, touch tablets, joysticks, trackballs, touchscreens, light pens, and digitizing tablets. Of these, the mouse and the touch tablet are far superior for most video pointing needs. The mouse, virtually unknown a year ago, by now needs no explanation. The touch tablet as a pointing device is just beginning to be noticed.

Touch Tablets

Touch tablets are just emerging as viable pointing devices. The Koalapad touch tablet is one example. (Editor's note: Another example is the Powerpad from Chalk Board, Atlanta, Georgia.) The Koalapad is a hand-held touch tablet with a drawing surface that allows the movement of a finger to create pictures on video displays. Locations touched on the tablet's surface are converted into X,Y coordinates that are sent to a computer through a game port or a digital interface. Game-port Koalapad touch tablets are analog devices and are comparatively inexpensive. The digital touchpad is more expensive and is compatible with any computer that will accept RS-232C inputs. The drawing area is pressure-sensitive; any blunt pointing device such as a finger or a retracted ball-point pen can be used.

Touch Tablets vs. Digitizing Tablets

A digitizing tablet is a flat panel that typically rests on a table top and produces accurate coordinate values for the location of a hand-held electrical stylus pressed against its surface. This has advantages and disadvantages in relation to touch tablets, which are actuated by touch rather than by special pens or styli. Touch sensing is an advantage in text editing, for example, when the typist must move a hand from the keyboard to manipulate a pointing device; the added step of picking up a stylus is a nuisance.

On the other hand, the digitizing tablet is superior to the touch tablet for the specialized application of digitizing drawings. Laying an arm or hand on the tablet ence 14) was used to build a prototype Dynabook system.

Although hardware limitations prevented commercial production of Dynabook, many of the features of the new interface technology can be traced directly to the prototyping efforts behind it. One of the most important products to come out of the Dynabook project was the Smalltalk language (reference 5). From these efforts followed many others that expanded the basic concepts to make them usable in a general computing environment, including newer versions of Smalltalk that introduced overlapping windows, the Xerox Star workstation (reference 12), which introduced icons, and a number of similar projects conducted by the LISP community using personal computers that execute LISP as their machine language.

Hardware for the New Interface Technology

These systems are unique in their attempt to coordinate the design of hardware and software. Many of the hardware features are predicated by the need to run more complex software while retaining an adequate level of system responsiveness. The systems use 16-bit processors (so far either the Intel 8088, found in the IBM PC and the HP 150, or the Motorola 68000, found in the Lisa). The integrated software requires at least 512K bytes of RAM and a half-megabyte of disk storage (often a Winchester hard disk).

Referring to these machines as microcomputers is misleading. Systems equipped with this much memory, a hard disk, and a 16-bit processor can approach the processing speed of modern minicomputers, since the personal computer need support only a single user.

The remaining hardware features, high-resolution bit-mapped graphics display and a pointing device, serve to increase the I/O (input/output) bandwidth. The high-resolution graphics display is important because it enables the computer to communicate information to the user far more efficiently than is possible with text-only and low-resolution displays. The old adage about a picture being worth a thousand words is, if anything, too conservative an estimate of the value of these displays. Whenever possible, the new systems take advantage of graphics to enhance communication with the user. They provide constant visual feedback to help guide the user and enhance the overall quality of the system. It is possible to display text in different fonts and to space text proportionally just as it will appear when printed, a technique called "what you see is what you get." This means that the user will have to go through fewer edit-print iterations to produce a document that looks right.

The pointing device is the input counterpart of the graphics display. Without a pointing device, menus can become an endless series of delays for the user who already knows what he wants to do and how to do it. Of pointing devices that are widely available—among them mice, touchscreens, trackballs, joysticks, light pens, and graphics tablets—the

to steady the drawing finger would be fine for a digitizer but would activate a touch tablet at the wrong location.

Touch tablet linearity (guaranteed up to approximately 7 bits) is also inferior to that of digitizing tablets (typically guaranteed up to 11 bits). However, touch tablets can allow a single pixel to be selected by pointing on a video display with 10 bits (10,024 points) of resolution in each dimension. This is achieved with visual feedback, rocking the finger around the tablet surface. In other words, even though the absolute *positional accuracy of touch-tablet sensing is only 99.0 percent (1 percent error) of the screen, the* relative *positional accuracy can be better than 99.9 percent (0.1 percent error). In the final analysis, touch sensing is adequate for most applications, including CAD/CAM (computer-aided design and manufacturing), where the visual feedback is sufficient to allow accurate pointing. For digitizing operations such as map tracing or graph tracing, the digitizing tablet is the better choice.*

Touch Tablets vs. Mice

The mouse is a hand-held video pointing device with a sensor in the bottom to detect motion over a flat surface. It has been adequately described in the many articles on the Apple Lisa computer (February 1983 BYTE). The mouse is the preferred pointing device for text-editing applications because it is the most comfortable to use and, with the exception of tablets, is also the fastest. (For a detailed analysis of the mouse's performance compared to other input methods, see reference 1.)

On the other side of the coin, the mouse is inferior to a tablet stylus or finger for drawing. Furthermore, the touch tablet is less expensive than the mouse and requires less desktop space. While most office-automation productivity tools in the near future probably will feature the mouse, I believe that the touch tablet will be the favorite on home computers and eventually will become an integral part of business systems.

Touch Tablets vs. Touchscreens

A touchscreen is essentially a touch tablet made of transparent material mounted in front of a video display. (Editor's note: The HP 150 uses an optical touchscreen. See October 1983 BYTE.) Touchscreens are primarily valuable for information retrieval from computers in public places where any one particular user does not enter frequent queries. A user's pointing arm will tire with prolonged use of touchscreens. Furthermore, a finger obscures small detail (such as text) when pointing. Being too close to video displays for prolonged periods may create problems in terms of eyestrain and screen radiation.

Touch Tablets vs. Joysticks, Light Pens, Etc.

Joysticks and trackballs have been investigated as alternatives to the mouse and the touch tablet. Their speed of locating a randomly placed target on a video display is inferior to the mouse's (reference 1). Although joysticks are the least expensive of all video pointing devices, they are inadequate for drawing and rapid pointing.

Light pens are potentially as inexpensive as touch tablets, but they have the same drawbacks as touchscreens: user fatigue and proximity to video display, and obscuring detail when in use.

In summary, I believe that touch tablets have some real advantages, in performance and cost, over other video pointing devices for many applications.

—George M. White

mouse is the preferred one. (See "Video Pointing Devices: Enter the Touch Tablet" on page 218.)

Mice have been compared with several other types of pointing devices (reference 1) and have proven superior to other methods with one exception: a skilled touch-typist could do slightly better with control sequences. Mice are cheaper to manufacture than most of the other devices as well. Mice are high-resolution devices; it is possible to point to a single pixel on a high-resolution screen. I've done it often on a 1024- by 800-pixel screen—try that with a joystick or trackball! Also, a mouse stays put if you take your hand off it, an important property when you're constantly alternating between a pointing device and the keyboard.

Software for the New Interface Technology

The most important and revolutionary aspect of the new interface technology is the software. It is possible to produce many types of systems with the hardware just mentioned that do not qualify as the new technology. There are three obvious components of this special software from the user's point of view: multiple overlapping windows, commands issued by selection from menus using the pointing device, and applications programs that can communicate information to other programs simply and consistently. Subsets of these features have been available in older products, but the whole package is more effective than any of the parts.

The use of windows and pointing devices is central to all of the new systems and is the most obvious improvement over older systems. When the system is in operation, the screen represents a workspace, often viewed as a desktop, and may be filled with several rectangular regions or "windows." (See "The Desktop Metaphor.") Usually, a single program is associated with each window, and it is through its window that a program communicates with the user.

The Lisa system represents system objects, such as files, in picture symbols or "icons." The idea behind icons is similar to the idea behind pictorial road signs: to convey maximum information in minimum time. Icons are one reason high-resolution graphics capabilities are important. Systems with screen resolutions inadequate to display icons make do with small boxes containing text.

Located somewhere on the screen at all times is a cursor that is linked to the pointing device. When the user moves the mouse, for example, the cursor moves proportionately. This cursor represents the focus of attention for the user. It may be in the form of an arrow that can point to a precise point of the screen. All input to the system takes place near the tip of the arrow, which is the cursor's "hot-spot."

The Desktop Metaphor

A revolution is occurring in computing. It is based on techniques for controlling computers by pointing to video symbols instead of typing commands on keyboards. It has given rise to the "desktop metaphor," which will characterize user interaction with business computers in the future.

The desktop metaphor refers to symbols on computer displays that represent office equipment. These symbols are not passive pictures but are typically used to control computer simulations of activities performed at a desk. The desk is presumed to be equipped with a telephone, file folders, paper pads, wastebaskets, and so on. The video symbols of these desktop accessories are called "icons." Icons are computationally empowered to simulate the real objects they represent. They are activated when the user points to them with nonkeyboard video pointing devices. An activated icon performs a computational task. For example, pointing to a picture of a sheet of paper and then to a picture of a wastebasket indicates that you want the sheet of paper thrown away (or removed from the screen by the computer).

In general, you can create, send, file, and/or discard messages, graphs, charts, electronic mail, and other documents on the computer by simply pointing to icons. The computer user no longer needs to be an expert to accomplish these tasks. Indeed, the user can rely on the shape and spacial arrangement of icons to provide clear and intuitive hints on their functions.

The intuitive nature of icons is no accident; it is the central point of the desktop metaphor. The user's knowledge of real-world desk equipment is designed to create analogies that carry over into the symbolic world of computer icons.

The desktop metaphor is actually a special case of a more general principle, the "physical metaphor" of computing, which was the brainchild of Alan Kay. Dr. Kay in this regard is the intellectual father of Xerox Star and Apple Lisa, which make extensive use of icons. His idea was that computers would be easier to learn to use if computer programs acted more like physical objects than like mathematical abstractions. People have good intuitions regarding physical objects. This intuition would help them to understand computers if computers were to exhibit similar properties.

In these systems the user might find overlapping sheets of paper symbolically displayed and might properly deduce that he can see obscured pages by moving the uppermost pages. This certainly makes the storage and retrieval of text files more comprehensible than an admonition to type something like "LOAD FILENAME.EXT".

The degree to which the "physical metaphor" signals a fundamental advance for man-machine communication may not be obvious. To fully appreciate the metaphor, consider that controlling a computer by typing text on a keyboard involves different mental skills and different parts of the brain than are required for drawing pictures or pointing to icons. Visual thinking takes place in the right hemisphere of the brain, while verbal thinking takes place in the left hemisphere of the brain (assuming normal dominance). When the average western thinker communicates with phonetic language, he uses primarily his left cerebral cortex. This is also the part of the brain that dominates during keyboard text communication with computers. The right hemisphere of the brain, on the other hand, is involved more with visual thinking and is believed to be the source of artistic and creative thought. Perhaps even more important is the fact that spatial and visual information is easier to memorize than verbal/textual information.

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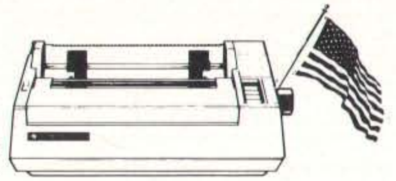

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The cursor facilitates selection and insertion. The chosen object, be it a command from the menu, an icon, a fragment of text, or a graphic image, is easy to reach quickly. It can then be set apart (highlighted) and manipulated. Highlighting the selected object provides important visual feedback, a feature often overlooked in conventional interface design. Without feedback, it is impossible to tell whether the system has responded to the user's request, so the user may repeat the command in an effort to be sure the machine understands. This is undesirable, particularly in systems that have type-ahead buffers.

The mouse can conveniently accomplish a couple of other operations. For example, it can drag textual and graphical objects about the screen to achieve a desired arrangement. Some systems provide "knobs" and "levers" with which to control the objects on the screen. In Lisa, windows scroll when the cursor drags small "elevators" along the edges of the window.

Another mouse application is called "rubber-band graphics." An example is the rubber-band window, where one corner of the window remains fixed and the diagonally opposite corner is tied to the mouse cursor. The window remains rectangular, but the lengths of its sides are varied by dragging the corner around on the screen, which stretches the window (hence the name rubber-band). The visual effect associated with this operation is quite impressive and one of the more pleasing aspects of the system. The same technique may be used in graphical drawing programs where lines, curves, and other graphical objects can be stretched or moved in rubber-band fashion.

Menus in these systems typically present only the options that are useful for the job at hand and avoid confusing the user with massive, largely irrelevant lists of possibilities. Because of this, menus are usually kept short and invalid selections cannot be made.

A valuable software capability found in the new systems is the ability to transfer data easily between two

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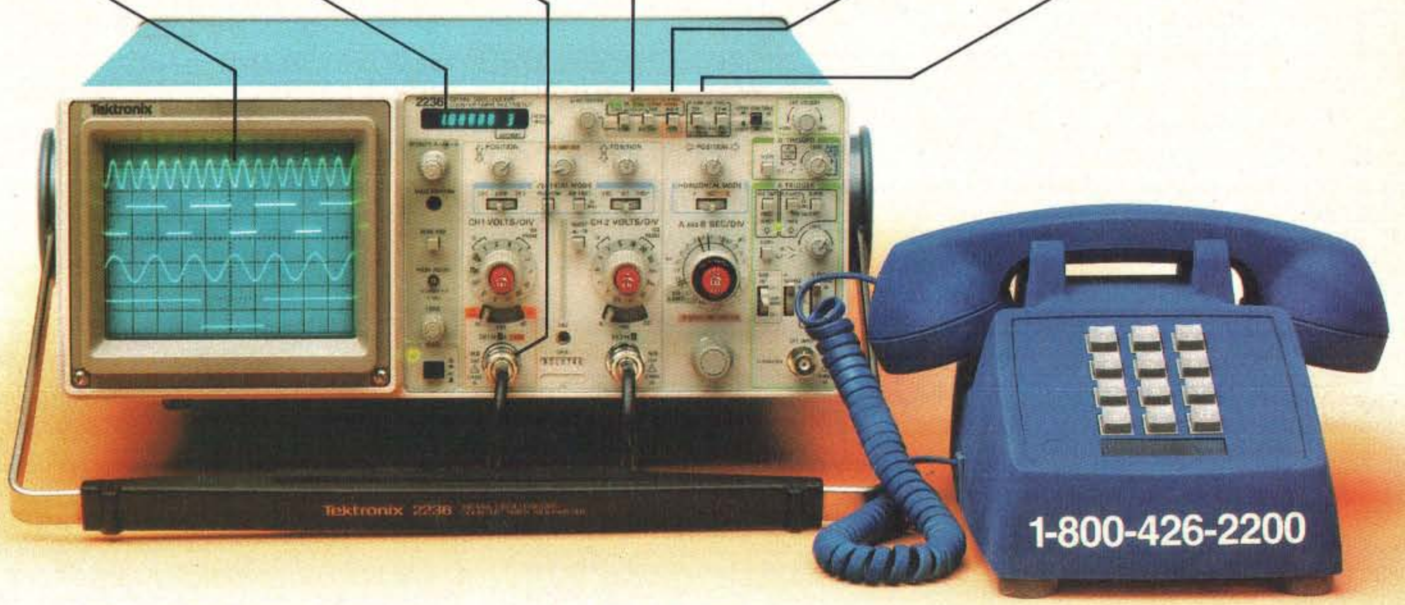

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applications programs. This enables the user to view the programs as a set of tools with which to manipulate data. It doesn't make sense to have to use one sort of "cut" command with a text editor and another with a graphics package.

To make these applications programs compatible with one another, it is necessary to adopt a uniform means of transferring data between them. One may view the exchange of data as occurring between two windows, each window containing a program. Any information that passes beyond the confines of a window is controlled by the desktop-manager program (whose "window" is the gray desktop area under the windows), which sees to it that the transfer between two windows is always accomplished in the same way.

Providing the ability to exchange information among different programs in this way is one of the most difficult aspects of designing these systems. To underscore this difficulty, consider that in both Lisa and Visi On, the initial offering does not support the complete transfer of information between any two programs. However, both companies claim that their products will eventually be able to support this kind of operation.

Psychology and Philosophy of the New Software

A great number of design decisions in the development of the new software were made on the basis of a few philosophical tenets. Many of these tenets were first analyzed in the design of the Smalltalk system (see "The Smalltalk Environment" by Larry Tesler, August 1981 BYTE, page 90, for a good description of these) and were later refined in the Xerox Star project.

Every effort to build one of these systems has been preceded by a long period in which a user-interface definition was hammered out. This definition specifies the allowable behavior of the system. All programs that run on the system are expected to conform to these guidelines. At least four reasons exist for proceeding in this way.

First, by limiting the number of ways in which a program can interact with the user and forcing all programs to obey these rules, the user has less to remember when learning and using the system.

Second, a good deal of effort can be spent in choosing the best forms of interaction and in insisting that all programs use them. This is where most of the philosophical tenets come into play.

Third, the programs necessary to do the graphical manipulations and manage the mouse are very complex. Often, they have to be written in assembly language to achieve adequate performance (this was the case with both Lisa and Visi On). By adopting the guidelines, it is possible for the manufacturer of the original software to provide these facilities so that developers of applications won't have to. Considering the size of Lisa's desktop manager—10 megabytes of source code—this is a worthwhile savings to the software developer.

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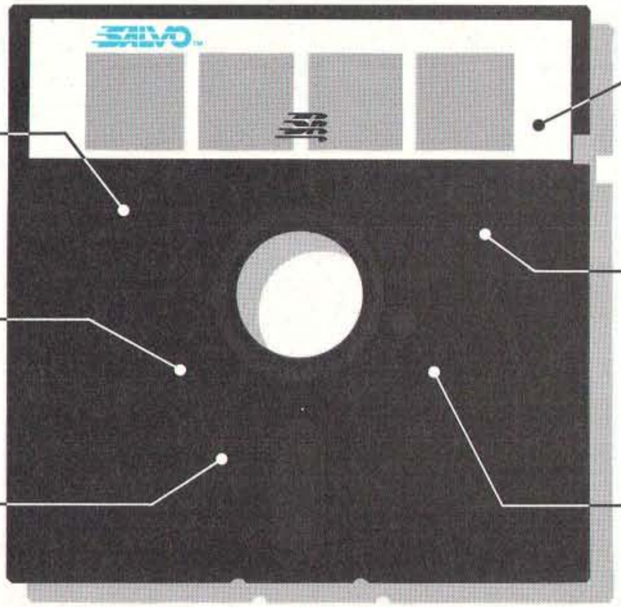

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The fourth reason is that a precise specification for all interaction makes it easier to control the transfer of data among applications programs, which is one of the most difficult problems in designing such a system.

The philosophical tenets of these systems are very similar and revolve around the concept of consistency. The idea is that data objects that are manipulated by computers can be thought of in the same way we think of real physical objects. There are two components when describing any operation on an object: the subject, which is the object itself or some reference to it, and the verb, which is the action to be performed on the object. Just as in the real world, where the same verb may be applied to many different subjects, so too can the same action be applied to different data objects in the system.

Moving an object to a different window can be accomplished in the same way for a sentence, a graphic image, or a block of numbers from a spreadsheet. First the object is selected, then the verb "cut" is sent to the object, cutting it out of the window it currently lives in. Next, a new location for the object is selected with the mouse, and the verb "paste" is sent. At no time does the user have to worry about whether the object being moved is text, graphics, or spreadsheet numbers. Of course, the program underneath this user interface has to be much more complex than a program with a separate kind of command for each type of object—it deals with many kinds of objects that can be "cut" and "pasted." Object-oriented languages like Smalltalk work particularly well for this kind of programming.

Simplicity is a component related to consistency. By using "point and click syntax," in which the user points to an object with the cursor and "clicks" (pushes a button on the mouse or lifts a finger from a touchscreen) to select it, it is possible to specify very complex types of behavior in a simple, consistent fashion. A system should be designed so that it is intuitive; when a user needs to do something he has never done before, he should be able to tell how to get started.

The new technology makes it possible to specify complex behavior in a simple consistent fashion.

What Is to Be Gained from All of This New Technology?

So far, there has been a lot of talk about pretty graphics and philosophy, but what is to be gained from using one of these systems? The answer to that question is simple: these systems will be easier to use, and the users of such a system will be more productive. Many people writing about this technology have the idea that these systems are primarily of use to novices. This is most emphatically wrong!

The Smalltalk system is in fact unavailable to this class of users (so far) and is used primarily by experts in preference to other systems. The same is true for similar systems developed by the LISP community. All of these systems are designed with a great deal of testing to determine what types of interaction are best for the user. While the emphasis is on testing with naive users, a great deal of testing with experts is also conducted. Arguments against their utility for experts center around two topics: it is inconvenient to switch back and forth between mouse and keyboard, and the new software is slower than the old-style software.

The argument against mice is wrong for three reasons. First, testing has shown that only a good touch-typist using control sequences can do better than a mouse (and most computer users aren't that good). Second, the systems incorporate keyboard control sequences as alternatives. Third, many people who have used such a system long enough to become proficient at it find they use the mouse far more than the keyboard.

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The speed argument is true in part. The new programs can be slower than the old, but this does not have to be true if they are carefully written and optimized. Furthermore, many of the operations that are slow on the new systems are not even possible on the old systems. Certainly the delays I have encountered on the Lisa should not be irritating to the user of a CP/M system with floppy disks or, for that matter, a user of a Vax 750 Unix system with 10 or more users.

After having used several types of computer systems to do large programming projects, I have formulated my own theory about the usefulness of the new interface technology. When you become proficient at any system, you begin to think less and less about what command to use for a particular situation. A sort of subconscious level of thought processes handles this task. You simply think to yourself, "I need to go compile this program," and your fingers type the necessary commands with little conscious effort. Meanwhile, your mind is busy considering what the results of the compile will be. Unfortunately, my fingers are prone to making errors on most systems. When this happens, my stream of conscious thought is rudely interrupted by the realization that the system is not doing what I wanted it to, and I have to stop and figure out what went wrong.

Often this unpleasant sequence of events occurs not because of any typographical error; my fingers had typed a perfectly valid command. It's just that the particular mode I was in did not understand how to deal with the command. One system I use, for example, offers six different ways to accomplish an exit, depending on the mode. It's not surprising that I often type some exit sequence and find I'm in the wrong mode for it to work or, worse yet, that the sequence does something totally unexpected.

The new interface technology makes "exit" a generic verb that can be executed in the same way for every program. This is analogous to the behavior of the physical universe, which is governed by a small set of

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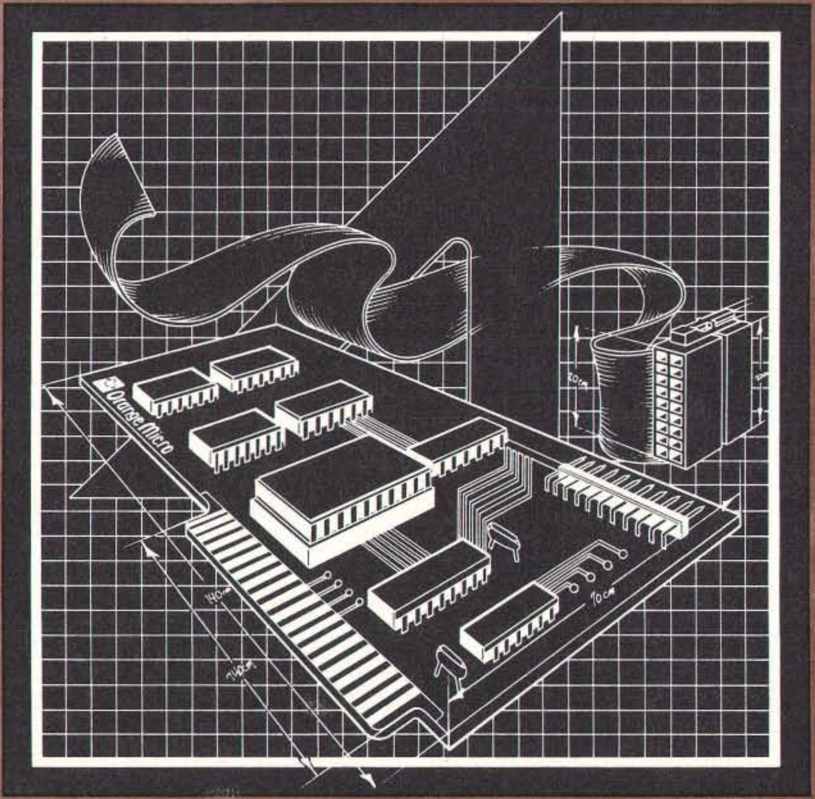

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laws that apply to objects no matter what they are.

Furthermore, the state of the system is always made readily apparent through visual feedback. Another nice feature of the new systems is that it is harder to make a typo using a mouse.

Simple, consistent computer systems make it easier for the subconscious lower level to do its work without interrupting the user's conscious stream of thought. This is the behavior that is expected from a good tool; a carpenter uses a hammer without pausing to remember how it works. Computer users who are competent technicians in this sense are rare, even among the experts that use a system every day. This need not be the case. The new interface technology can let most people become competent technicians for the applications they use on a day-to-day basis.

Disadvantages of the New Technology

The new interface technology is not without its drawbacks. Programs that use this technology are much more complex than older programs that accomplish similar tasks. As a result, software will be more expensive to produce. But such software will have a much broader market appeal, so the expense will be justified. The increased complexity of the new software will help to spur the introduction of more powerful personal computing languages such as Logo and Smalltalk. BASIC is no longer a suitable language for these machines. It doesn't have the power of expressibility needed to make full use of the graphics capabilities of the new machines.

There is a tradeoff in speed associated with these machines as well. If the old-style software were run with the resources of the new machines, it certainly would be faster. The new software runs as fast as the better 8-bit software of today. But the increase in usability of the new software justifies a slight decrease in performance. All the performance in the world is useless unless it can be harnessed and put to good use.

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Conclusion

The new interface technology represents the next era in user-interface design. The potential advances in productivity are at least comparable to the advances made in going from punched cards to full-screen editors. It will also finally be possible for the average person to use a computer in his day-to-day work. The advent of local-area networks will be another feature of this style of computing. Apple is committed to providing communications and database-management applications for Lisa in the near future. This provides some indication of the important role information processing and communication will play in the new systems. A great deal of work is also being done on voice recognition by computer, which would eliminate the final stumbling block to man-machine communication—the keyboard.

It is interesting to speculate on what the next step will be after the new interface technology has been assimilated. The new technology is related to work on artificial intelligence. It represents an attempt to use the best capabilities of man and machine in synthesis. Once this has been accomplished, it will be easier to begin shifting more and more human capabilities to the computer. The eventual result would be an artificially intelligent computer.■

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Robert W. Warfield (8429 Hearth #31, Houston, TX 77054) is a graduate student in computer science at Rice University.

George M. White received a B.S. from Michigan State University in math, chemistry, and physics; a Ph.D. in chemical physics from the University of Oregon; and was a postgraduate fellow at Stanford University. He worked for seven years with the Xerox Palo Alto Research Center and is currently chairman of the board of Koala Technologies (3100 Patrick Henry Dr., Santa Clara, CA 95050).

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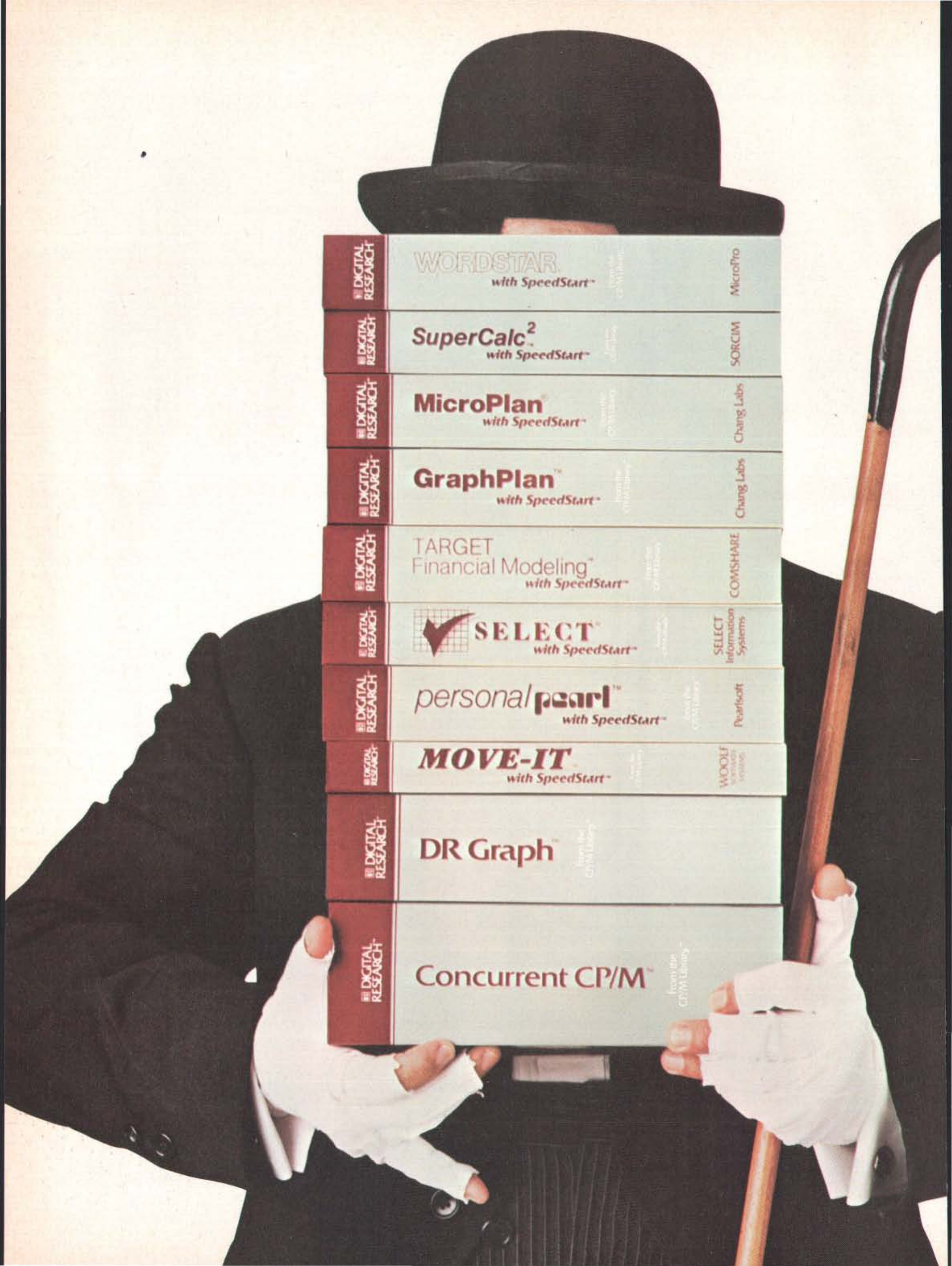
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Trackball-Interfacing Techniques for Microprocessors

This interfacing approach lets you adapt trackball devices to your interactive personal computer applications

by Edward W. Andrews

The age of interactive computing is upon us, and a variety of I/O (input/output) devices have been developed to supplement the keyboard in providing convenient human-to-machine interfacing. Unfortunately, in the past only simple joysticks and pushbuttons have been priced low enough to suit home computer applications. The LT200, a recent product from Disc Instruments of Costa Mesa, California, has brought the trackball within reach of the home computer market. This product provides accurate positioning of the cursor displayed on a CRT (cathode-ray tube), and it provides TTL-compatible outputs that can be readily interfaced with a microcomputer without elaborate and costly circuitry. Moreover, the LT200 costs less than $100, representing a major savings compared to the trackballs designed for commercial and military markets that cost more than $1000.

This article describes general trackball-interfacing techniques and a simple hardware/software interface approach that can be adapted easily to any home system.

Trackball Concepts

A trackball is an interactive control that consists of a solid ball, 1½ to 3 inches in diameter, mounted in a base such that part of the ball's surface is exposed, allowing the ball to be rolled with the palm or fingertips. The ball's rolling motion is coupled to optical encoders that generate pulses to indicate the direction and rate of ball rotation. These pulses can be coupled to a microprocessor, which can then create proportional X-Y motion of a CRT-displayed cursor.

A simple hardware/software-based trackball-interfacing approach can be adapted to any personal computer system.

The precision with which a trackball can be moved suits it to detailed interactive graphics applications. Commercially it has seen wide use in computer-aided-design (CAD) systems. Other applications include interactive analysis of medical X-ray, nuclear, and ultrasound images. Some video-arcade games have also featured trackball controls.

Figure 1 shows the internal construction of the LT200 trackball. Two optical interrupter disks (the slotted wheels) form the basis of an optical encoder for each trackball axis. The ball rests on two perpendicular rods on which the interrupter disks are mounted. Any movement of the ball causes at least one of the rods to rotate, in turn causing disk rotation and, thus, pulse-train generation. The frequency of these pulse-train signals is proportional to the ball-rotation speed along each axis. Most trackballs generate 200 to 500 pulses per revolution. The LT200, for example, generates 480 pulses per revolution.

Because the two rods are perpendicular, one encoder's output represents X-axis movement while the other encoder's output represents Y-axis movement. Each encoder includes sensing logic that determines forward or reverse (or left or right) movement along the corresponding axis; a trackball device therefore furnishes four signals indicating movement in +X, −X, +Y, and −Y directions. When used to control cursor positioning on a CRT, the trackball must be properly oriented with respect to the CRT to obtain the proper correlation between ball movement and cursor movement.

Basic Interfacing Concepts

Note that a trackball is essentially an incremental or relative input device. By rolling the trackball, an operator signals his intent for the displayed cursor symbol to move in a given direction and at a given rate, away from the current cursor position. In response to trackball rotation, the cursor moves to a new position based on its current position.

A review of some fundamental CRT display-addressing concepts illustrates how the incremental trackball signals can be interfaced to a computer. Consider a CRT display having an X-Y matrix of 256 by 256 pixels (picture elements). Within such a matrix, the displayed cursor location on the CRT can be specified by an X, Y number pair. One 8-bit number can uniquely define all possible horizontal X pixel locations, or addresses, on the CRT display, starting with 0 on the left edge and extending to 255 at the right edge of the display. Similarly, a second 8-bit value uniquely defines all possible vertical Y pixel locations of the CRT, starting with 0 at the bottom and ending at 255 at the top edge of the display. If the X and Y values defining the absolute cursor location can be varied in response to the trackball, an interactive control results.

Implementation Approaches

As figure 2 shows, a trackball interface can be built using two simple hardware up-down counter circuits. Here the X-axis uses one counter and the Y-axis uses a second. With the trackball +X output connected to the up-count clock, and the −X trackball output connected to the down-count clock, the counter increments and decrements appropriately in response to trackball X-axis movement. The Y-axis trackball outputs are connected similarly to a second counter, which in turn responds to Y-axis trackball movement. These counter circuits can then be interfaced to a microprocessor's data bus through an input port, allowing the processor to read or periodically poll the input port to determine the current absolute X, Y trackball coordinate. Using this data, the microprocessor can position the cursor on the CRT. If this input port is read and the displayed cursor position is updated at a high rate (more than 25 times per second), an interactive control results.

A trackball is essentially an incremental or relative input device.

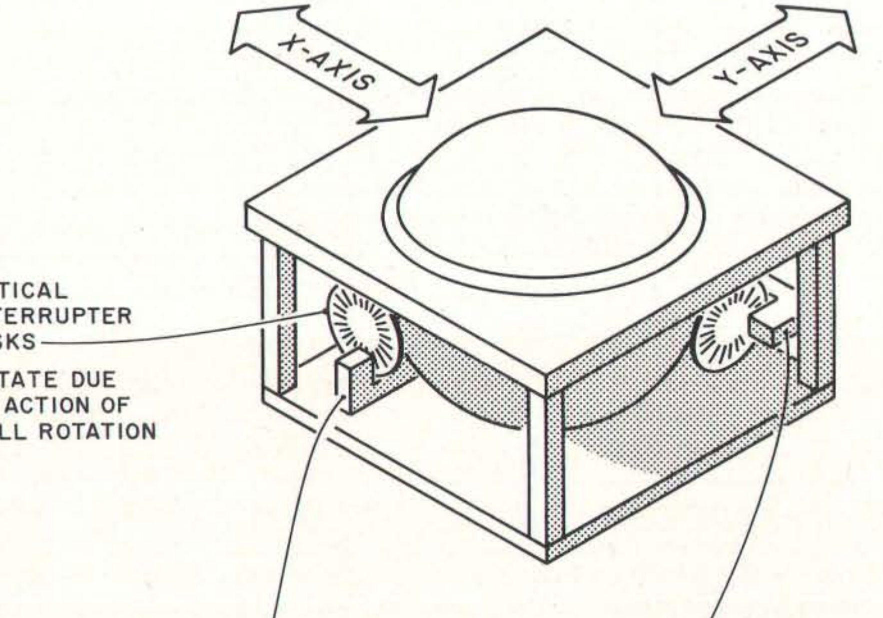

X-AXIS
Y-AXIS
OPTICAL INTERRUPTER DISKS
ROTATE DUE TO ACTION OF BALL ROTATION
DIRECTION SENSING LOGIC AND TTL DRIVERS
+X
−X
DIRECTION SENSING LOGIC AND TTL DRIVERS
+Y
−Y

Figure 1: *An internal look at Disc Instruments' LT200 trackball.*

As shown, upper- and lower-limit detection logic must be included in the counter design to prevent counter roll-over, which could occur if the trackball is unceasingly rolled in one direction. The X-axis counter, for example, must be inhibited from further up-counting when the rightmost pixel coordinate, 255, is reached. Should such limiting be omitted, further +X pulses from the trackball would cause the counter to overflow from 255 to 0. If this overflow were to occur, you would see the cursor jump abruptly from the far right side of the display screen (X address = 255) to the far left side of the display screen (X address = 0). With boundary limiting properly implemented, the trackball appears to slip whenever a display screen edge is encountered. Such boundary limiting must also be included for the left, top, and bottom cursor boundaries.

An Interrupt-Based Interface

We have seen the basic trackball interfacing concepts demonstrated with a hardware-intensive approach. While counters can be readily configured to directly implement a trackball interface, other less hardware-intensive approaches are also possible. One such method uses interrupt concepts and software-based up-down counters to respond to the trackball output pulses. In other words, the counters just detailed are functionally implemented in software, and the trackball output pulses are connected as vectored interrupts to a microprocessor system.

With an interrupt-based approach, you must think of the current trackball X- and Y-cursor coordinates as residing in two locations in the micro-

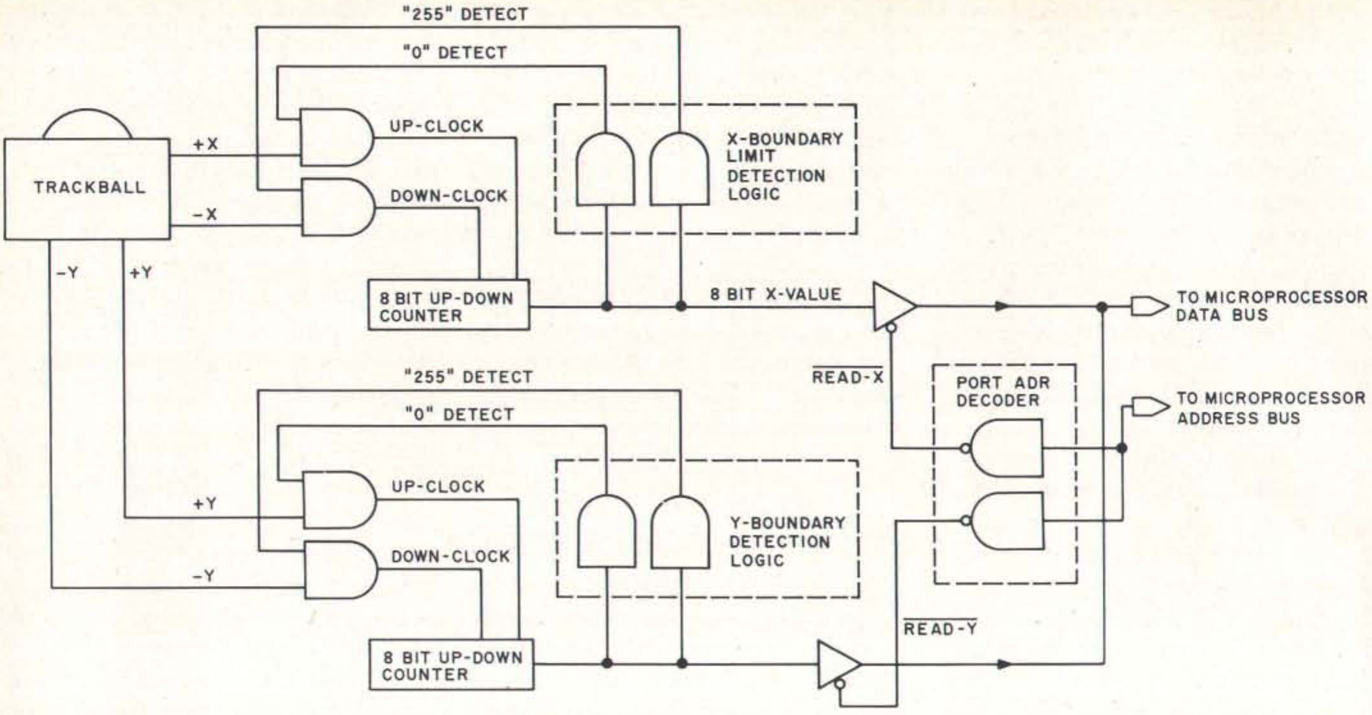


Figure 2: *A block diagram of a fundamental hardware-based trackball interface.*

processor's RAM (random-access read/write memory). Rather than drive a hardware-counter circuit, the trackball signals are now connected as vectored interrupts to the processor system. An interrupt controller, such as an Intel 8259, can be used to add vectored-interrupt capability to a computer system. Alternately, the trackball can be interfaced to an existing interrupt structure. In any event, with an interrupt-based approach, the software interrupt-handler routines operate as up-down, software-based counters.

With the trackball signals connected as interrupts, for example, as a +X trackball pulse is received, the microprocessor is vectored to an interrupt-service routine whose job is to increment the data contained in the X-cursor-coordinate memory location. Similarly, the −X interrupt-service routine decrements the data contained in the X-cursor-coordinate memory location in response to a −X trackball pulse.

Figure 3 shows simple flowcharts of the four interrupt-service routines required for a fully interrupt-based implementation. Notice that upper/lower boundary detection and limiting is also included in these interrupt routines.

With the interrupt routines maintaining and updating the absolute cursor X, Y coordinates, the operating computer program would be responsible for monitoring and acting on the changing cursor-coordinate data. That is, the operating program (which the trackball signals interrupt) would continually read the two memory locations designated as the X- and Y-cursor coordinates and respond to changes in these values. Figure 4 illustrates this activity. In this simple example, the sole purpose of the operating program is to move the cursor interactively in response to trackball motion. An actual application would expand on this basic activity, enabling the trackball coordinates to interactively vary or control higher-level functions.

An interrupt-driven approach to trackball interfacing minimizes hardware but places extra demands on software.

The TIP Approach

Although an interrupt-driven approach to trackball interfacing can minimize the interface hardware, it does place extra demands on the software. In addition, many home and personal computers and their operating systems are not interrupt-based. An effective yet simple interfacing approach, which I'll call TIP, for trackball input polled, is shown in schematic form in figure 5. This method offers a polled approach to accepting trackball data and is readily adapted to almost any microprocessor-based system.

The TIP interface consists of two 4-bit up-down counters driven directly from the trackball output signals. One counter is connected to the +X and −X signals and in turn registers trackball rotations in the X-axis. Similarly, the other counter is connected to the +Y and −Y signals, registering Y-axis trackball movement. These two signals are then connected to a single 8-bit input port that can be read by the microprocessor.

Each of the counters is configured to generate a two's complement, 4-bit signed number. As the TIP input port

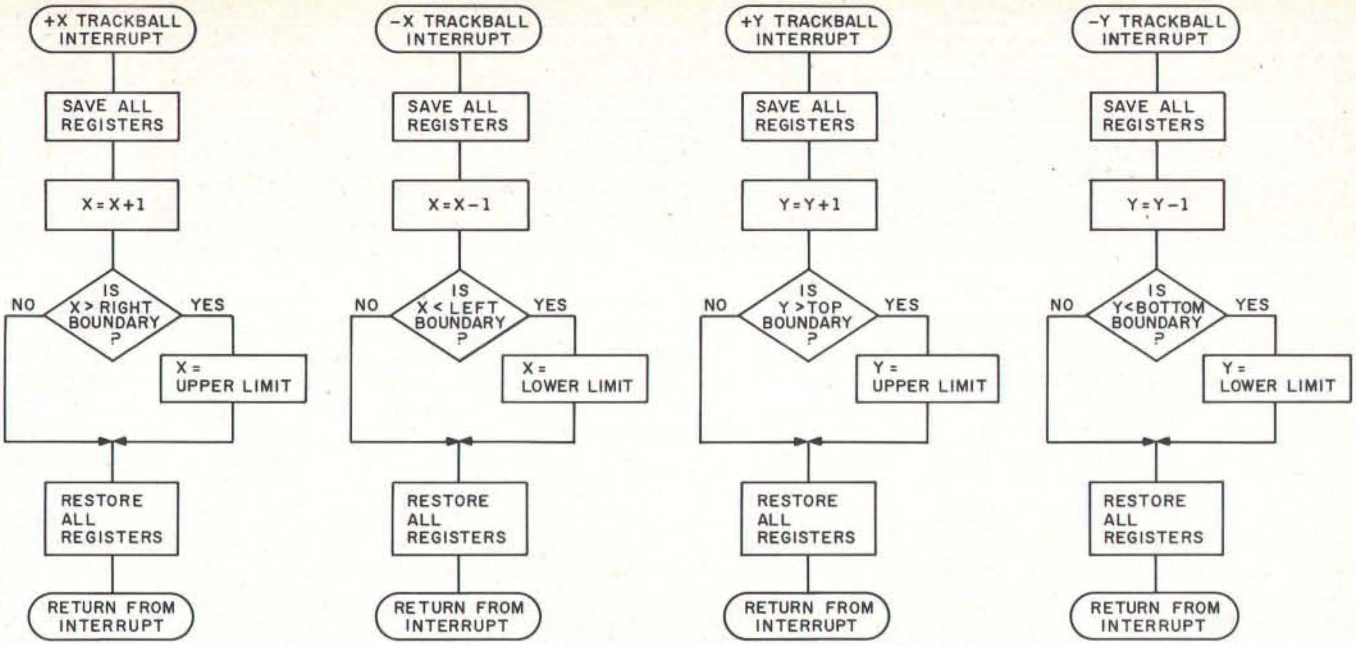


Figure 3: *Flowcharts for the four interrupt-handler routines required for a vectored-interrupt trackball-interface approach. Note that boundary checking is included in these routines.*

is read by the microprocessor, the two numbers retrieved represent an accumulation of the operator's most recent trackball actuation. In effect, the data read is an X, Y vector, indicating the direction and magnitude (speed) of trackball rotation. The software then alters the current cursor-location values based on this move vector. This method differs from the approach suggested by figure 2, in which the interface-counter hardware actually holds the absolute cursor location, rather than a relative move count. Figure 6 shows the data format as it is read from the TIP input port.

TIP Circuit Details

The four trackball signals, +X, −X, +Y, and −Y, are received and gated by the Schmitt-trigger device IC1 in figure 5. We chose a Schmitt device to increase the noise immunity of the input circuitry, therefore reducing the chance of random electrical noise from adversely affecting the counter operation. IC4 (X-axis) and IC5 (Y-axis) are TTL-type 74LS192 up-down, 4-bit binary counters. These counters are structured to count symmetrically from zero, each able to count within the two's complement number range from −7 to +7. NAND gates IC2b (X-axis) and IC3b (Y-axis) detect the uppermost count boundary, +7, and work in conjunction with IC1 to prevent an ongoing stream of up-count clocks (+X and +Y trackball signals) from causing an undesired counter overflow. Similarly, NAND gates IC2a (X-axis) and IC3a (Y-axis), detect the lowermost count boundary, −7, and, with IC1, prevent an ongoing stream of down-count clocks (−X and −Y trackball signals) from causing an undesired counter underflow.

IC7 is an 8-bit clocked register with three output states and is used as a combination data-latch and data-bus driver. A latch here ensures that a stable, unchanging data byte would be presented during the processor's READ operation. In addition, just after the data latch is clocked to hold the current trackball X, Y data pair, both X and Y counters are reset to zero. Thus, after every TIP register is read, the counters start over in accumulating operator input.

The LED (light-emitting diode) indicators are optional and not required for circuit operation; however, I found them invaluable in debugging my wire-wrapped prototype.

Address and Data-Bus Interface

Comparators IC8 and IC9 form the address-bus decoder. These two

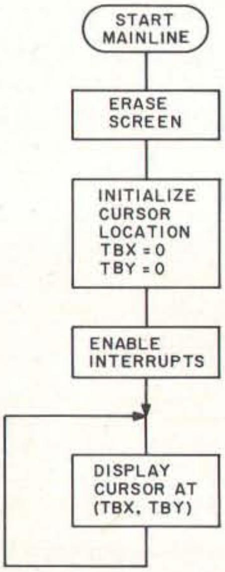

START MAINLINE
ERASE SCREEN
INITIALIZE CURSOR LOCATION TBX = 0 TBY = 0
ENABLE INTERRUPTS
DISPLAY CURSOR AT (TBX, TBY)

Figure 4: *The flowchart of a simple main program designed to work with the figure 3 interrupt routines. The trackball-coordinate values TBX and TBY are the variables that the interrupt handlers update.*

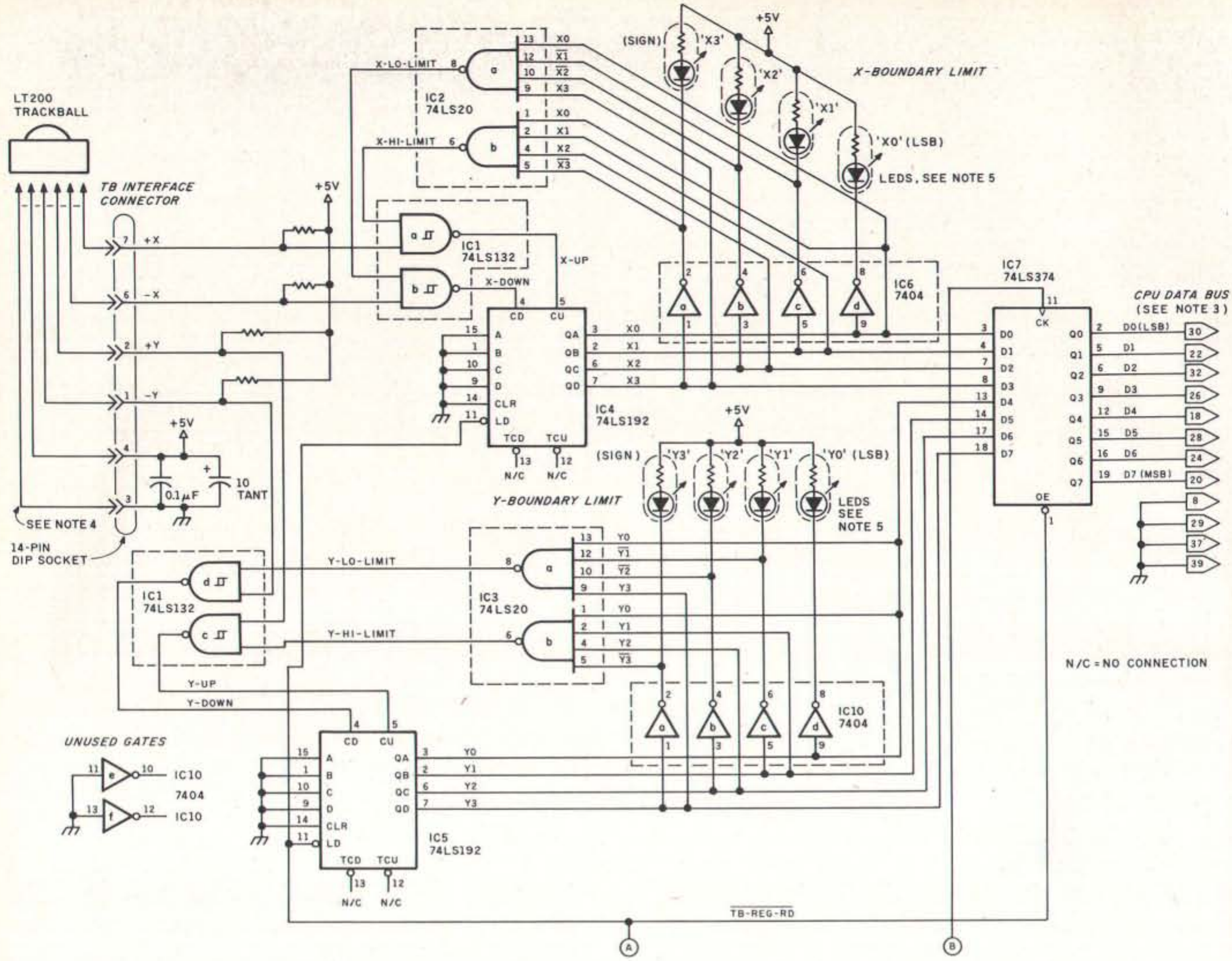


Figure 5: *The TIP (trackball input polled) interface schematic. Connector pinouts are shown for a TRS-80 Model I computer.*

chips are configured as an 8-bit comparator. As shown, the lower 8 bits of the microprocessor address bus are compared with a data value, set by an 8-station switch. The comparators are gated further by an $\overline{\text{IOREAD}}$ signal. In this way, the TIP input register is mapped into the microprocessor I/O space. The actual port assignment is determined by the switch settings of S0 (LSB) through S7 (MSB). When a given switch position is open (off), a logic 1 is set; closing the switch (on) results in a logic 0 state.

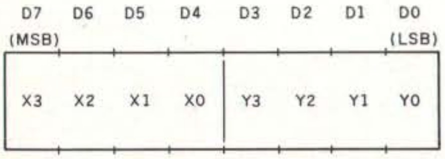


Figure 6: *The TIP input-port data format. The lower 4 bits represent a delta Y (DY) value, and the upper 4 bits represent a delta X (DX) value. This pair of two's complement values, each having a number range from –7 to +7, represents the most recent operator actuation of the trackball.*

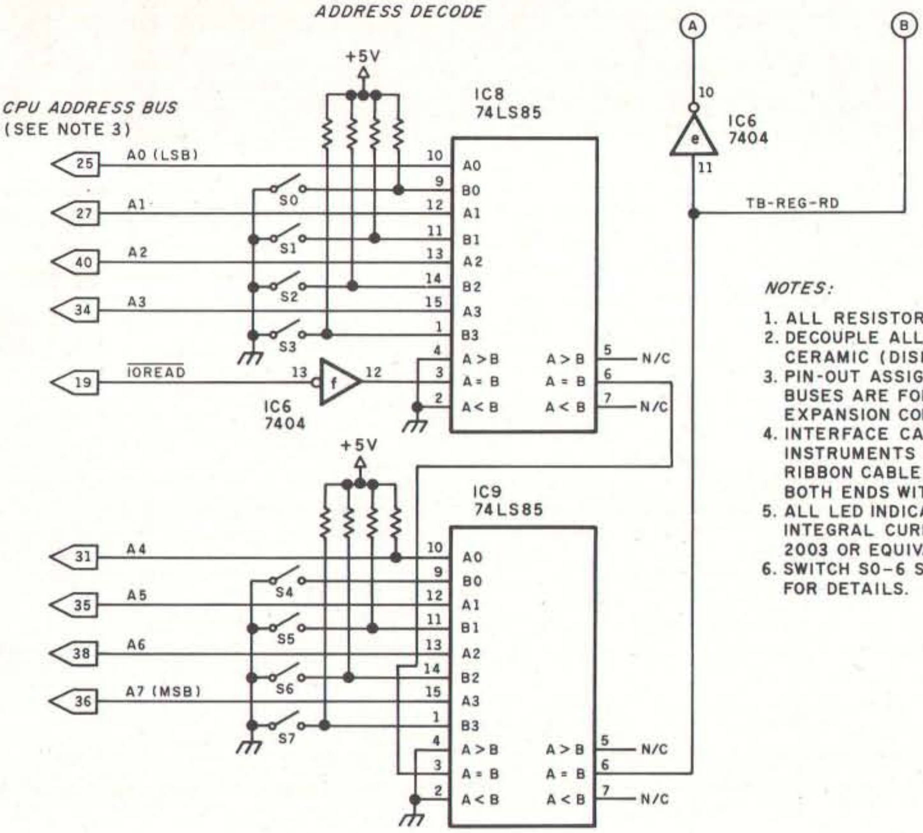
Although a TRS-80 computer was used to demonstrate concept feasibility, the corresponding address bus, data bus, and $\overline{\text{IOREAD}}$ signals of any microcomputer can be connected to the TIP interface. If desired, the TIP data port can even be memory-mapped. For this memory-mapped approach, the address-decoding circuitry has to be expanded to compare 16 bits (or more). Additional 74LS85 comparator chips can be cascaded, or other combinational logic techniques can be used. Any high-true, address-decoding signal can be used to drive the point called "TB-REG-RD" of figure 5; however, TB-REG-RD must occur at least one gate delay before $\overline{\text{TB-REG-RD}}$.

As shown, the microprocessor data bus is connected to the output of IC7. Data bit D7 is the most significant bit (MSB), and D0 is the least significant bit (LSB).

A TRS-80 Demonstration

The address and data bus pinouts shown in figure 5 correspond to the expansion-interface pin assignments for the TRS-80 Model I computer, which I used to evaluate and test the circuit concepts. This expansion interface connector makes available all the key Z80 processor signals needed to connect the TIP circuitry.

Listings 1 and 2 show simple



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1. ALL RESISTORS ARE 2.2 KΩ, 0.25 W, UNLESS NOTED.
2. DECOUPLE ALL CHIPS WITH 0.1 μF, 50V MONOLITHIC OR CERAMIC (DISK) CAPACITOR.
3. PIN-OUT ASSIGNMENTS SHOWN FOR ADDRESS AND DATA BUSES ARE FOR CONNECTION TO A TRS-80 MODEL I EXPANSION CONNECTOR CABLE.
4. INTERFACE CABLE BETWEEN TIP CIRCUIT AND DISK INSTRUMENTS LT200 SHOULD BE 14-CONDUCTOR RIBBON CABLE, LENGTH AS REQUIRED, TERMINATED ON BOTH ENDS WITH A MALE, 14-PIN DIP PLUG.
5. ALL LED INDICATORS SHOULD BE PC-MOUNTABLE; WITH INTEGRAL CURRENT LIMIT RESISTORS (DIALIGHT 547-2003 OR EQUIVALENT).
6. SWITCH S0-6 SETS I/O PORT ASSIGNMENT. SEE TEXT FOR DETAILS.

Listing 1: *A TRS-80 Model I (Level II BASIC) main program that controls cursor movement in response to trackball actuation.*

```
10     REM *******************************************
15     REM *                                         *
20     REM *       TIP DEMONSTRATION PROGRAM         *
30     REM *       --------------------------        *
40     REM * This program will move a block cursor   *
50     REM * about the CRT screen in response to     *
60     REM * the movement of the trackball.  A       *
70     REM * mode can be selected which will result *
80     REM * in "Etch-A-Sketch" like operation.      *
90     REM * This program was written and tested on *
100    REM * a TRS-80, Model I, computer, with       *
110    REM * Level II BASIC.  Note. the TRS-80,      *
120    REM * Model I computer has a CRT screen       *
130    REM * resolution of only 128 X 48 PIXELS.     *
140    REM *******************************************
150    REM
160    CLS
170    REM --- SET INITIAL X,Y VALUES
180    Y=20:X=50
190    REM --- ASK OPERATOR IF HE WANTS TO TRACE
200    PRINT "ENTER 1 FOR TRACE MODE, 0 FOR NO TRACE"
210    INPUT A
215    CLS
220    REM --- MAIN LOOP STARTS HERE----------------
230    REM --- TURN CURSOR BLOCK "ON"
250    SET(X,Y)
260    REM --- READ TIP I/O PORT AND GET DX, DY
270    GOSUB 800
280    REM --- TURN CURSOR BLOCK "OFF"
290    REM     THIS ON-OFF SEQUENCE CAUSES
300    REM     CURSOR TO FLICKER SLIGHTLY WHICH
310    REM     DIFFERENTIATES IT FROM OTHER
320    REM     ON-SCREEN GRAPHICS BLOCKS
330    RESET(X,Y)
340    REM --- WAS TRACKBALL ROLLED? IF NO, LOOP BACK
350    IF DX=0 AND DY=0 GOTO 250
360    REM --- YES, TB WAS ROLLED; CHECK IF TRACE SELECTED
370    IF A=0 GOTO 410
380    REM --- IF TRACE SELECTED, TURN CURRENT BLOCK ON
390    SET(X,Y)
400    REM --- NOW UPDATE CURSOR COORDINATES
410    X=X+DX
420    REM --- NOTE: SUBTRACT DY BECAUSE "+Y"
430    REM     DIRECTION IS "DOWN" ON TRS-80 SCREEN
440    Y=Y-DY
450    REM --- PERFORM BOUNDARY CHECKING AND LIMITING
460    IF X>127 X=127
470    IF X<0   X=0
480    IF Y>47  Y=47
490    IF Y<0   Y=0
500    GOTO 250
```

Listing 2: *A subroutine that reads the TIP port and separates the DX and DY elements.*

```
700     REM ***********************************************
710     REM *                                             *
720     REM * This subroutine will read the TIP I/O port,*
730     REM * separate the X and Y values, and convert    *
740     REM * them into a pair of BASIC signed numbers    *
750     REM * which the mainline can use to update the    *
760     REM * cursor position.  Here, the TIP I/O port    *
770     REM * was 0 (All address switches closed).        *
780     REM * This routine was written and tested on a    *
790     REM * TRS-80, Model I computer, level II BASIC    *
800     REM *                                             *
810     REM ***********************************************
850     REM
860     REM --- READ THE I/O PORT
870     TIP=INP(0)
880     REM --- SEPARATE X AND Y FROM THE SINGLE DATA BYTE
890     REM     AND PLACE EACH IN THE LOWER 4-BITS OF A NEW
900     REM     VARIABLE PAIR, DX AND DY
910     DX=(TIP AND 240) * .0625
920     DY=(TIP AND 15)
930     REM --- NOW CONVERT THESE NUMBERS INTO SIGNED VALUES
940     REM     WHICH TRS-80 BASIC WILL UNDERSTAND! 1ST, X
950     REM --- IF THE 2'S COMP NUMBER IS +, WE'RE DONE
960     IF DX < 8 GOTO 1000
970     REM --- IF THE 2'S COMP NO. IS -, THERE'S MORE WORK
980     DX = DX - 16
990     REM --- NOW DO THE Y VALUES
1000    IF DY < 8 GOTO 1030
1010    DY = DY - 16
1020    REM --- ALL DONE.....
1030    RETURN
```

TRS-80 Level II BASIC main and subprograms that read the TIP input port and move a graphics block around the screen in response to the trackball movement. The TIP port is easily accessed using the TRS-80 INP command. In my tests, I used input port address 0 (all address-compare switches closed).

You may notice that I turn a graphics block on using the SET command, read the input port, and then turn the graphics block off using the RESET command. With the cursor stationary (no trackball motion), this technique causes the cursor block to flicker slightly. This flicker is a great help in differentiating the cursor block from other graphics characters that may also be on the screen.

Another feature of the test program is a deposit mode. In this mode, the computer operates much like the Etch-A-Sketch toy, leaving a trail of dots (pixels) behind the moving cursor.

Design Variations

Since the LT200 produces 480

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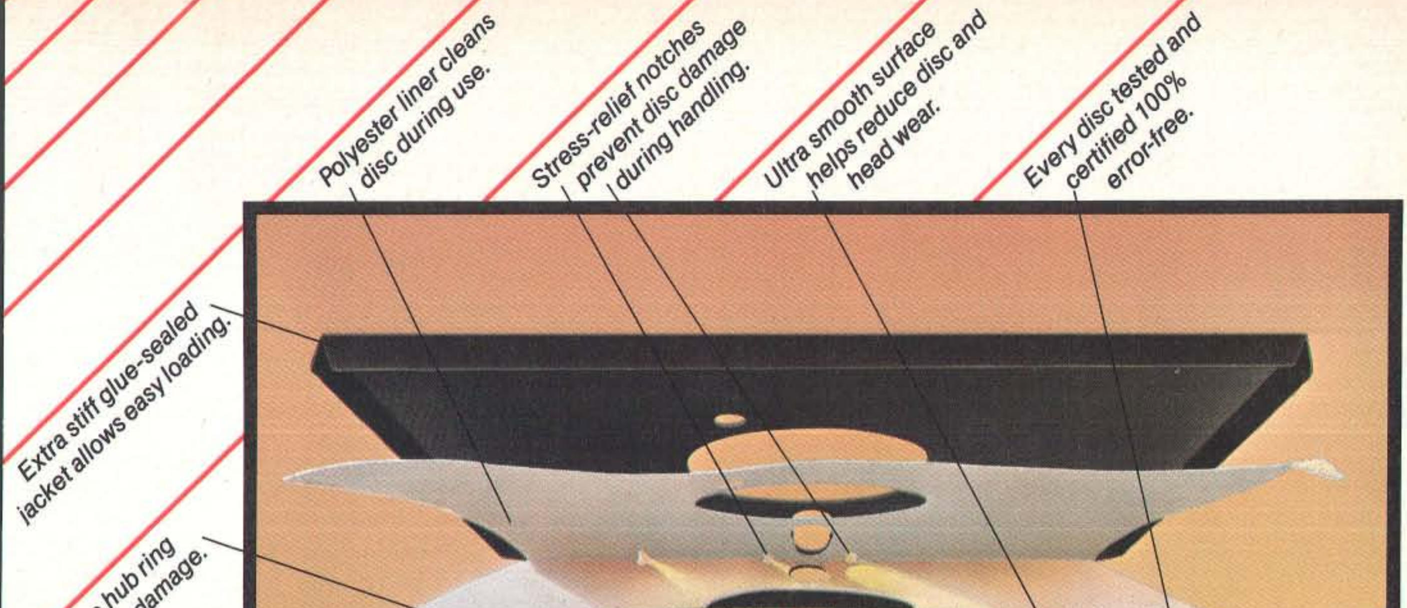
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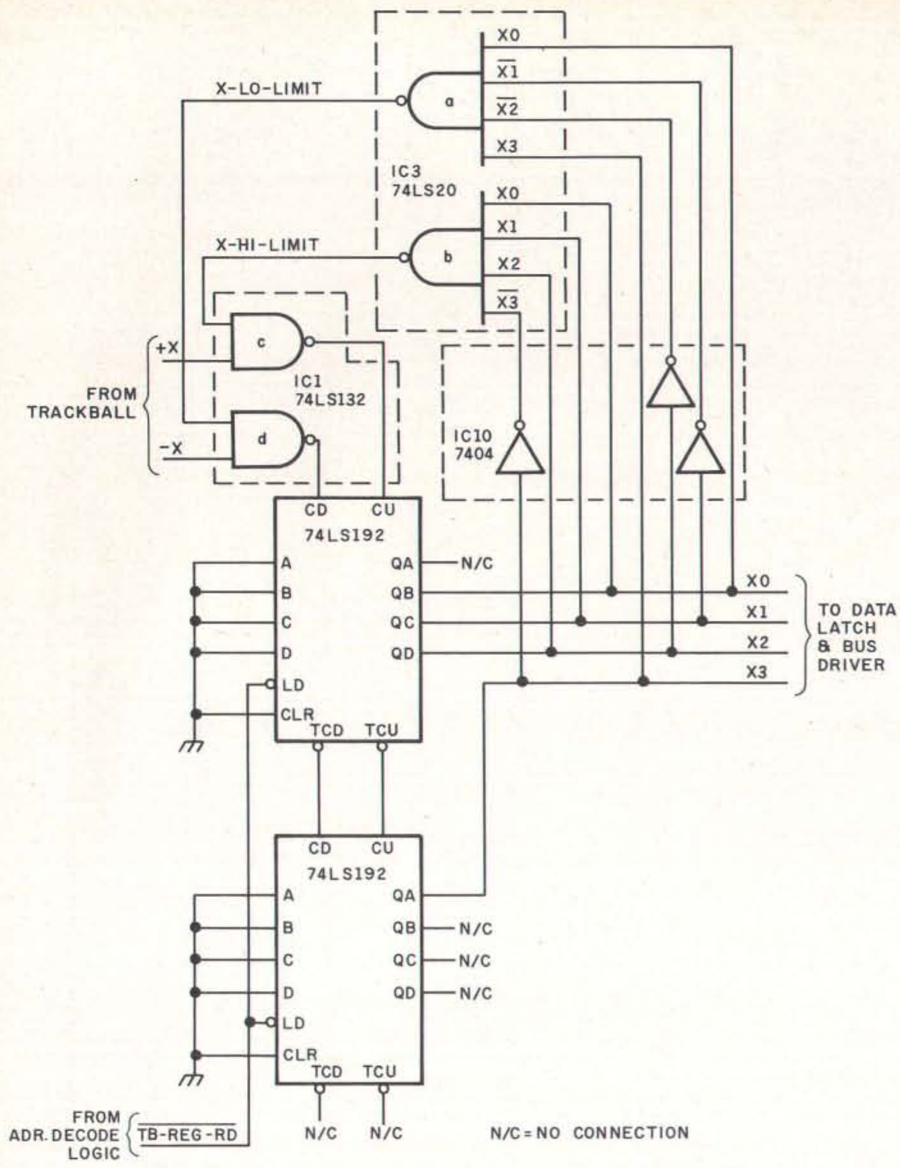

Figure 7: *A design variation that allows the TIP trackball counters to prescale the trackball pulses.*

pulses per revolution, just over half a rotation of the LT200 trackball element moves a displayed cursor from one screen edge to the other screen edge when operating within a 256- by 256-pixel matrix. For detailed cursor placement, at which a trackball device intrinsically excels, you may find the trackball excessively sensitive with the LT200/TIP interface scheme as shown. There are two ways to reduce the trackball sensitivity: a simple hardware change or a software approach.

To reduce the trackball sensitivity, it is necessary to prescale the incoming trackball pulses. Figure 7 shows how an additional 74LS192 counter circuit can be connected to each axis of the TIP interface. This approach extends the effective range of the counter from 4 bits to 8 bits. The TIP interface port and the upper/lower boundary checking, however, are still connected to only 4 bits. As shown, the 4 bits selected ignore the LSB of the first counter chip, effectively dividing by two the trackball pulses seen by the TIP I/O port, resulting in a trackball that produces only 240 pulses per revolution. If desired, the two lowest order bits of the first counter can be ignored, resulting in a trackball that is prescaled by 4, effectively producing only 120 pulses per revolution.

These hardware variations can be made to the design as shown by the TIP schematic of figure 5. To maintain symmetry, both the X and Y axes should be treated in the same fashion.

The scaling operations performed by the hardware changes of figure 7 can also be performed in software after the TIP data port is read. A simple divide-by-two operation can be applied to the X and Y data values. However, the effective number range that the TIP X and Y trackball values can represent is reduced from the −7 to +7 range to a −3 to +3 range. This reduced range adversely affects the ability of the trackball interface to represent a vector-like value indicating the direction and magnitude of the desired cursor move. The hardware approach as discussed, however, prescales the trackball pulses while completely retaining this vector-like characteristic.

Summary

A trackball can be interfaced easily to a personal computer. The TIP approach is both simple and inexpensive. A TRS-80 demonstration validated the design approach. While the TRS-80 did prove effective for evaluating the concept, I feel that a trackball device is better suited to higher resolution graphics systems having a minimum of a 150- by 150-pixel matrix.

Overall, the Disc Instruments LT200 trackball is well constructed. The design is mechanically simple, having few moving parts. While perhaps a bit lightweight to survive the demands of a video arcade, it is well suited to the home and office environment.

With the advent of the low-cost LT200 and similar products that no doubt will soon be offered by other vendors, the time has come to add the power and convenience of the trackball to the home computer.■

Edward W. Andrews (18640 Arden Ave., Brookfield, WI 53005) holds a B.S. degree in computer science and works at General Electric's Medical Systems Operation. In his spare time, he enjoys volleyball, racquetball, and home computing with emphasis on computer-graphics applications.

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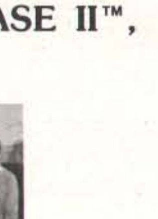

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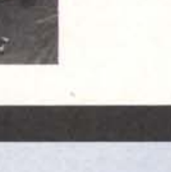

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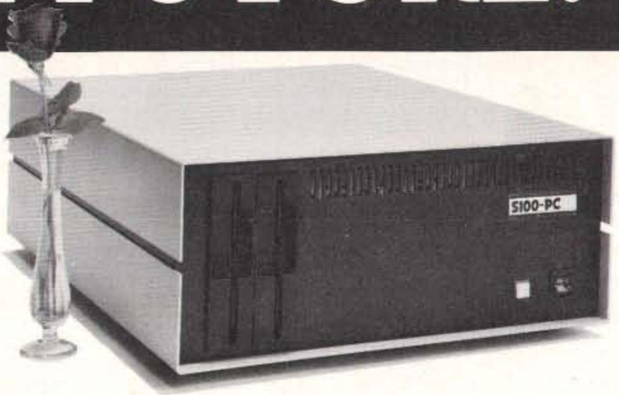

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The User Interface: Two Approaches

Both philosophy and pragmatism are viable courses

by Martin Herbach, Richard Katz, and Joseph Landau

In this article we present two approaches to the construction of an efficient user interface. The first, by Martin Herbach, provides his philosophical point of view that too often software developers are so wrapped up in the video-display aspects that the functionality of the program suffers. A text box by Richard Katz provides some basic guidelines that can help in user-interface development. Joseph Landau follows by giving us an example of a philosophy that evolved from direct user feedback as his company began the process of increasing the capability of one of its products without complicating its use. While the user interface continues to be a topic of heated discussion, you will see from these two points of view that we are still far from any universal agreement about how to blueprint man-machine interaction.

How Is a Computer Like an Elephant?

by Martin Herbach

Perhaps no piece of computer jargon is more shrouded in mystique than "user interface." Like the blind men's elephant, the term means many things to many people. Rather than concentrate on the tasks that people are trying to perform, too many of us software people have gotten hung up in the mechanics of how users physically communicate the various elements of these tasks. We've transformed a willing servant into a wall of icons and windows, a snake of display management, a tree of gold to the minds of some marketing managers, and rope for a Gordian knot.

When you clear away the jargon-induced fog, a user interface is merely that part of a program that simulates a more appropriate computer to run the rest of the program. In other words, it's really the solution to a hardware problem. We're asking a vast segment of our population to use computers for all kinds of tasks, but we're stuck with a "standard" setup, a box with a processor and a couple of floppy-disk drives, a 200-line-resolution monitor, and a keyboard without a key marked Return.

The most significant thing about this computer is the user, a technologically naive but competent business worker with limited time. Users include managers, secretaries, executives, real-estate agents, dentists, financial analysts, and myriad others with a need to operate with more information more efficiently. Their tasks include creating and modifying documents, filing and retrieving documents and records, preparing presentations, free-form drawing, planning schedules, and manipulating spreadsheets as well as such vaguely defined objectives as analysis.

A user interface simulates a more appropriate computer to run the rest of the program.

Software should be designed around the uses to which it will be applied; those applications of the software must come to the user easily and intuitively. Some ways to make a program easy to use are having fewer and simpler options, and a consistent structure, and hiding sophisticated options where unsophisticated users won't be intimidated by them. Having natural-language feedback to confirm command and option choices as well as friendly error-diagnosis messages that enable error correction in as few keystrokes as possible are other important elements. But many seemingly straightforward techniques are surprisingly overlooked in some of the most recent designs.

Only after "intuitive functionality" has been displayed should we look at how the user will physically operate the program. And this is where we tend to redesign the hardware.

One practical problem with spending many aggregate years on the development of such low-level phenomena as multiple-window managers and wastebasket icons is that we might shortly find our code incorporated in the next generation of video-controller chips—assuming that our approach is as successful with the user as we hoped it would be. If it is, I feel that it will be much better implemented by hardware.

I have nothing personal against prototyping the next generation of professional computers, but I wonder how many man-years of software development will have to be amortized over how short a period. In any case, it's reassuring that there are pressures that will coax software vendors to return to solving higher-level problems. Heaven knows the user has them.

The specific use for office-automation computers is increased information-management efficiency. One metaphor that is in vogue to convey this capability is the top of a "cluttered" desk. Many capable minds expended tremendous efforts to produce a detailed simulation of file folders, in-baskets, clocks, pads of paper, and a ubiquitous moving arrow. Get the arrow squarely on the proper file folder and eventually you wind up with some of your desktop simulating a cumbersome word processor. Clearly the word processor is the afterthought, while the window manager, icon manipulator, rodent priority interrupt handler, and wastebasket janitorial routines got the bulk of the development resources. Some reasons for this state of affairs are

1. We computer types know more about video management than calendar management.
2. Redesigning hardware is fun.
3. There's hardly any fun in designing another word processor.
4. There's hardly any fun in selling another word processor.

To illustrate the varying approaches that can be taken in designing productivity software, let's examine a representative feature, multiple windows. At the lowest level (technology), multiple windows imply the management of screen regions, so that one region can be modified without disturbing the rest and so that the original contents of the region can be restored later. If we start with that definition, we start asking questions like these:

1. How much resolution do we have or need?
2. What about color?
3. How do we scroll a portion, or region, of a screen?
4. What about nongraphics configurations of the target computer? Do we support them? Do we optimize for them?

Note that these are all really hardware questions. The danger is that we spend so much time investigating these topics that we forget to ask questions like the following:

Multiple-task windowing is the most natural way to express task concurrency.

1. What function will I put my windows to?
2. For word processing, can I have windows on separate documents simultaneously?
3. Can I have multiple windows on the same document? (This may actually be harder than 2! Consider rejustifying the contents of a window on page 100 because of a change in the window on page 1.)
4. For spreadsheet applications, can I view my data one way (say, as formulas in 20-character-wide columns) in window one and another (say, current values in 5-character columns) in window two? This is something that very few of the stand-alone spreadsheets (where windowing was pioneered) got right.

These functional capabilities of windows are what must be looked at first. They may not be as sexy as rubber-band borders and scrolling panels, but a proper user interface is one that defines the maximum functionality in the most intuitive fashion. (For some all-purpose software-development guidelines, see the "Interfacing Users and Software" text box on page 250.)

The Xerox/Lisa/Visi On approach is predicated on the simultaneous viewing of multiple tasks (as opposed to multiple views of the same task). For some people, this may not provide an easy-to-use, productive environment. When my desktop contains four tasks, such as memos to read or write, correspondence to review, and a couple of designs in progress, my tendency is to push three aside and pick one to work on. The clutter that I referred to earlier is something that computers should eliminate, not reproduce. An additional problem is that the current generation of microcomputer systems hasn't sufficient video resolution to allow the display of adequate amounts of multiple tasks. This problem is not permanent, however.

Now that I have played the devil's advocate, let me state that many of the concepts introduced with the window-management style of user interface are very valuable. Object-oriented data flow could be the most important. The ability to communicate information among tasks visually is very natural. The only better way is to integrate the tasks so that the communication is not required.

Multiple-task windowing is the most natural way to express task concurrency. It's so natural, in fact, that many sophisticated observers are convinced of Visi On's ability to do more than one thing at a time. Of course, without some sort of task manager to schedule resources, concurrency is impossible, and this has not been provided for the microcomputer environment—yet. When it does happen, the window-manager scheme will get a real workout. Until then, I hope that software designers concentrate on improving what the user gets to do inside a window rather than getting to it.■

Martin Herbach is a founder of and program designer at Sorcim Corporation (2310 Lundy Ave., San Jose, CA 95131).

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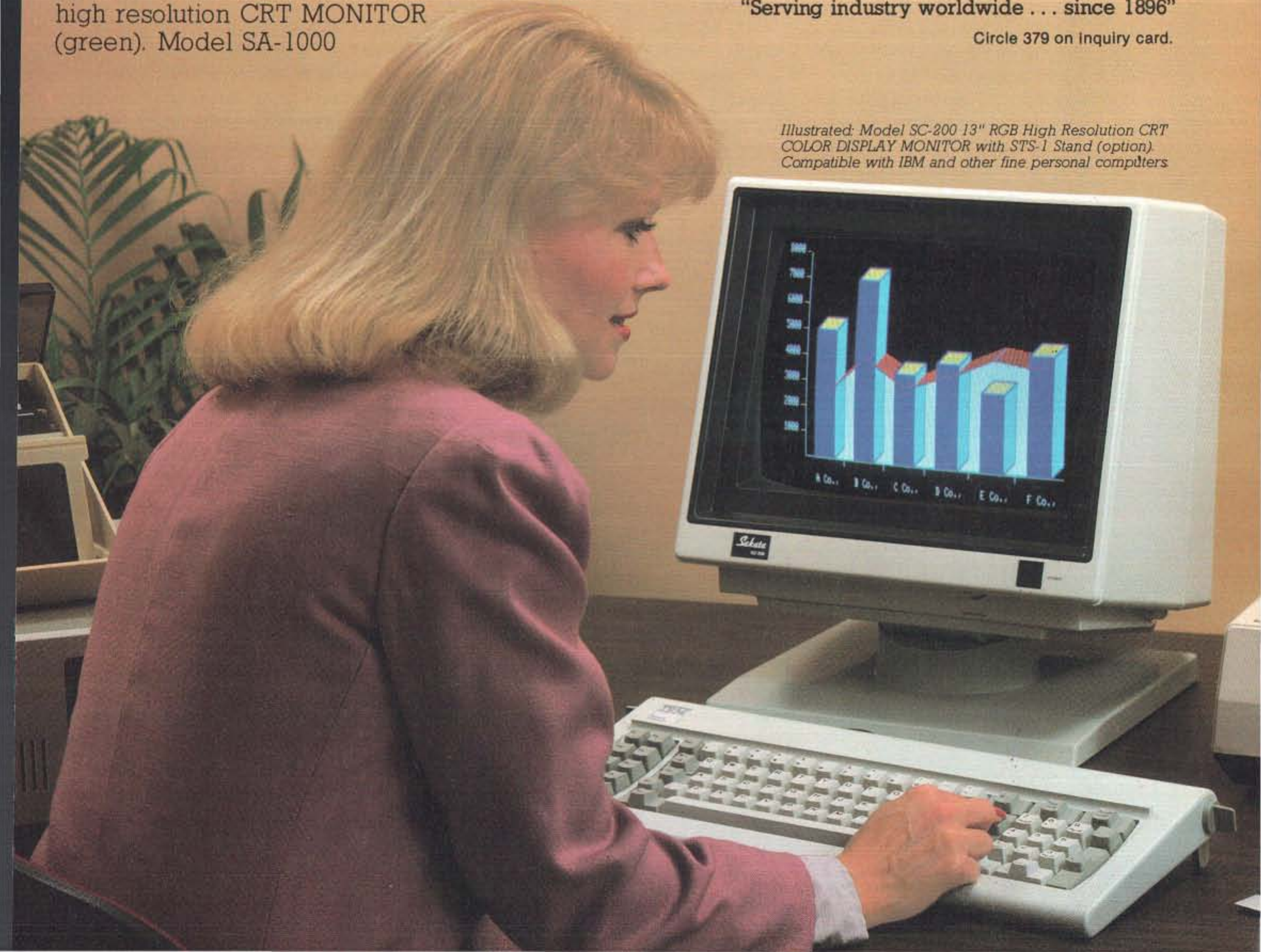

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Interfacing Users and Software

by Richard Katz

As software developers trying to accomplish today what AI (artificial intelligence) may someday be able to assist with, you must apply your intelligence instead. Collect what you know about the program and express it as well as you can to clarify how to use it. Included here are several guidelines that you might think of as a sort of software extension for Strunk and White's The Elements of Style, *for, indeed, the guidelines begin in that very place.*

1. Practice clear writing techniques. *Study books like* The Elements of Style *and* Clear Technical Writing *by John Brogan. Hire and work closely with an experienced technical writer during the development stage. A course on technical writing may also be a worthwhile investment.*

2. Focus on the application. *Consider what the application program needs to do. Imagine yourself as the user trying to get through the program for the first time. Better yet, find someone to be a first-time user. Write down what you expect the program to do and what it must do. For example, if you are using a word-processing program, you ought to be able to type in a letter, save it on disk, print it, retrieve it and look at it again, make changes, and save it again.*

3. Include on-screen help capability. *A tutorial demonstrates what software can do, but it cannot provide immediate assistance. A good tutorial illustrates a meaningful use of a program and demonstrates how to use the program to make it do that one thing. Along the way, it shows the commands that must be entered and what they do within the framework of the example. However, the tutorial is of necessity separate from the program itself. It cannot give you information about program controls while you actually operate the program. On-screen help can do so.*

Numerous approaches have been tried for on-screen help capabilities. While few are truly successful, the help capability nonetheless offers great potential for making program controls obvious.

Make it clear how to access the help capability by including a message such as "Press F1 for help" at the beginning or, if possible, continuously while the program is running. Also, clearly identify how to leave the program to return to the operating system. Few programs do this well. In many programs, either the exiting information is very obscure or it is difficult to get to the help screen that contains the exiting information. Thus, the trusting user can get trapped.

I recommend starting the design with a two-level approach that first presents the user with an overview help menu. From this menu the user selects topics, thus providing individual control over the learning process.

For instance, a project-planning and management-control program informs the user at the beginning to press the question mark (?) key to get help. Then the overview help menu shown below appears on the screen.

```
What kind of help do you want?
1. Where am I, anyway?
2. How do I enter data in this field?
3. How can I make changes?
4. I'm done here. What do I do now?
Press 1, 2, 3, or 4:
```

4. Orient users to program controls. *Orientation is what happens your first day in high school or college. You learn where the library is, when to register for classes, how to get an adviser, where the laundries and restaurants are, and so on. In a help screen, use the orientation form to identify program controls. On the left side of the screen, describe in everyday language the things that the user will need to do. On the right side, show the keys to press or commands to enter. For example, sup-*

How Is a Computer Like an Onion?

by Joseph Landau

Versaform is a forms-oriented database product for nontechnical end users. You can use it to design or copy a form on the computer, perform computations, produce output on preprinted forms, and create reports and analyses. Because of Versaform's orientation to existing business forms, you can continue to follow familiar procedures and use familiar data formats. Essentially, Versaform provides a way to construct a database from a business's existing paper-form records.

While implementing a new Versaform feature, we confronted the problem of making an inherently complex task seem as simple as possible. We realized that each new feature brings the burden of learning it, but how can we continue to provide more functions without making our product more complex and harder to learn?

The Need

The new feature, called File Lookup, adds a multifile access capability to Versaform. It enables the system to search for data on a secondary file and automatically enter this data on the current form the user is filling in.

For example, suppose an invoice (the primary form) is being filled in (see figure 1). Versaform is able to check entries against an internal table of valid part numbers, find descriptions and prices, and compute extended totals and column totals, all automatically. Internal tables, however, are limited to 99 entries, which is adequate for professional offices *pose the user selects item 4 from the help menu. The next screen the user sees looks like this:*

```
What to do next:
• To save your work, enter /S
• To print a report, enter /O
• To leave the program, enter /Q
• To clear the work area, enter /Z
• To retrieve an old plan, enter /L
• You can also work on the project plan
from a different view
• To select another view, enter /V
```

The screen above could be enhanced further by listing the page number in the user guide that explains each of the subjects in greater detail.

5. Eliminate extraneous information on the screen. *Brevity engenders clarity, provided you strengthen the verbs, use the active voice, and eliminate the deadwood. By being succinct and including only what is important, you will be able to clarify program use. Users won't have to dig through a lot of information that's not pertinent to their situation.*

In the help screen above, each instruction begins with "To do this" on the left side. Descriptive verbs such as save, print, *and* retrieve *provide more clarity than a broad verb like* use. *The definite nouns* your work, a report, *etc., add to clear understanding. The verb* enter *on the right side explicitly directs the user's action.*

6. Use help to document program error messages. *Another aid for the user explains how to resolve situations that create error messages. Although this capability logically belongs in on-screen help, it rarely occurs. Possible reasons are that it requires extra programming or that it takes up additional disk space.*

To provide this assistance requires that you give each error a separate number, write a detailed explanation of the error message, and describe some action to circumvent the error. Then create a data structure and triggering mechanism to present them at the proper times. For instance, suppose the user of a spreadsheet program makes an error while entering a formula. The user enters the formula "+A1+3" and forgets to include an additional operand following the "*." Spreadsheet programs generally respond to this by printing a short message such as "FORMULA ERROR" or by producing an annoying beep. Now, the user is stuck; the only solution requires erasing the formula from the entry line. The beep or nebulous two-word message is more irritating than helpful.*

In most spreadsheet programs that have on-screen help, when the user requests help a full page of information appears. But it is the same descriptive page that is available even if the user had not made the error to begin with. A program that has true on-screen error help should print a message like the one shown below.

```
You have made an error in the formula
you are trying to enter.

To continue, you must first correct the
error or press (whatever) to clear the
entry.
```

Note that no attempt is made in the message to diagnose the formula error; a diagnosis is not essential. The vital information tells the user how to continue. Including error message analyses such as the ones above further reduces the apparent and actual dangers in using a computer program.

Richard Katz (412 Green St., San Francisco, CA 94133) is a technical editor for Osborne/McGraw-Hill Book Company.

---

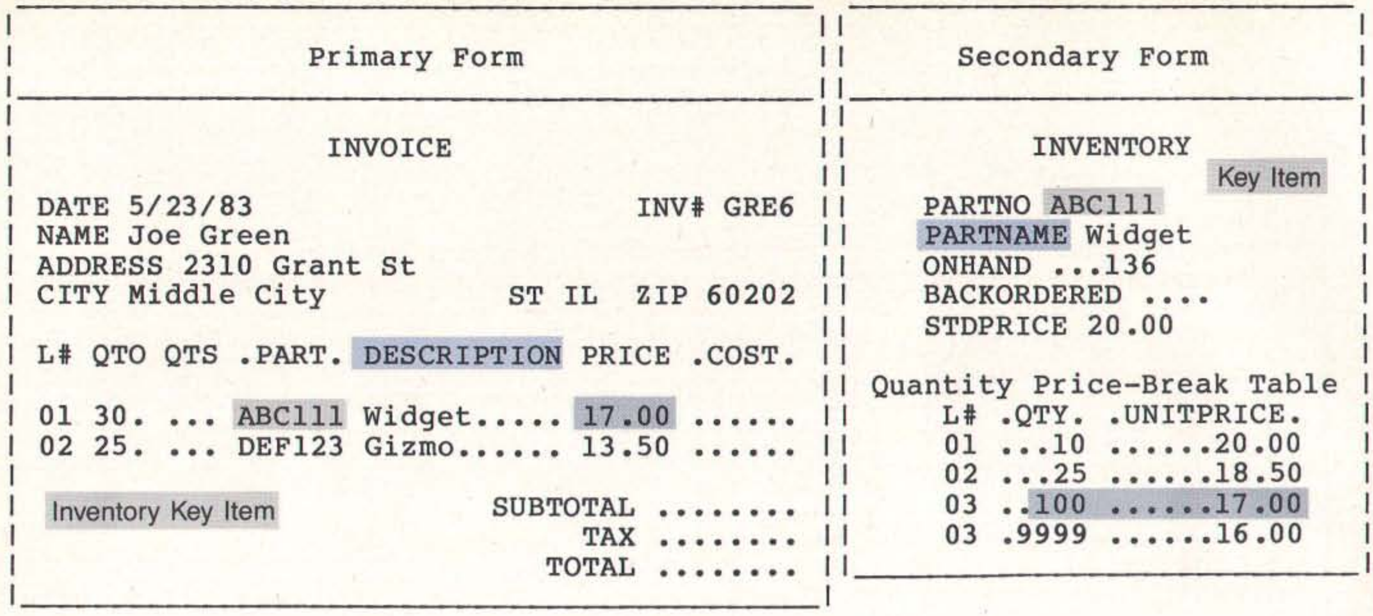
but not large enough for inventory information in many retail and wholesale businesses. Our solution was to allow the needed data to be accessed directly from a separate inventory file—either on a hard disk or on another floppy disk.

In addition to locating the values for description and price on the inventory (secondary form) and filling them in on the invoice, File Lookup also finds out from the inventory whether there is a large enough supply to fill the order and subtracts the quantity ordered from the quantity on hand. Or, if the quantity on hand is not sufficient to fill the order, back-order information is automatically entered on the inventory. To handle these tasks, the new feature combines multifile access with user-defined procedures necessary for the conditional updates.

The Mechanics

We began the process of designing the user interface for the File Lookup feature with an outline of the functions involved:

1. Exactly when will the desired action be executed?
2. Where will the lookup data be found (which record, on which file, on which disk)?
3. Where will the system look for the information it needs to find the required record—that is, where is the key?
4. The system must be told what to do with the data it finds:
    a. Instructions for moving data in both directions between the two forms (records).
    b. What calculations to perform.
    c. Under what conditions certain operations are to be performed.
5. If the lookup form has a columnar area (a repeating group), as in the Quantity Price-Break Table in the inventory in figure 1, which line



```
 ___________________________________________  _____________________________________
|                                           ||                                     |
|              Primary Form                 ||           Secondary Form            |
|___________________________________________||_____________________________________|
|                                           ||                                     |
|                INVOICE                    ||              INVENTORY              |
|                                           ||                          Key Item   |
| DATE 5/23/83                  INV# GRE6   ||    PARTNO ABC111                    |
| NAME Joe Green                            ||    PARTNAME Widget                  |
| ADDRESS 2310 Grant St                     ||    ONHAND ...136                    |
| CITY Middle City          ST IL  ZIP 60202||    BACKORDERED ....                 |
|                                           ||    STDPRICE 20.00                   |
| L# QTO QTS .PART. DESCRIPTION PRICE .COST.||                                     |
|                                           || Quantity Price-Break Table          |
| 01 30. ... ABC111 Widget..... 17.00 ......||     L# .QTY. .UNITPRICE.            |
| 02 25. ... DEF123 Gizmo...... 13.50 ......||     01 ...10 ......20.00            |
|                                           ||     02 ...25 ......18.50            |
|  Inventory Key Item        SUBTOTAL ......||     03 ..100 ......17.00            |
|                                 TAX ......||     03 .9999 ......16.00            |
|                               TOTAL ......||_____________________________________|
|___________________________________________|
```

Figure 1: *Primary- and secondary-form interaction. While you are entering data on the invoice, the File Lookup feature discussed in the text finds information in the inventory on another file and automatically enters it on the invoice.*

will contain the data? The desired line can be located in a number of ways:

a. Look for an exact match with the values in one of the columns.
b. Look for the first entry exceeding a certain value (as in a tax table).
c. Find a figure in a range between two columns.

First Design

Consistent with its forms-related environment, Versaform provides throughout its programs a variety of on-screen forms you fill in with instructions for the system.

For the File Lookup feature, our first on-screen form appeared as illustrated in figure 2. It has been filled in as it would be to perform the functions described in the invoice/inventory example. In brief, it provides these instructions to the system:

Lookup Trigger Item—This is the item on the primary form that triggers the lookup. That is, the search will actually begin when the user fills in the item called Part on the invoice. This field is filled in automatically by the system when the form appears on the screen.

Secondary-File Disk, Secondary File—The form to be looked up will be found in the inventory file on Mydisk.

Key-From1,2—Each Versaform file is identified by its unique key item, which may be a single field or a concatenation of two fields. To locate the secondary form, the system must know where it will find that form's key item among the data entered into the primary form (the current form in which information is being entered). In the example, that data will be found in the Part item on the invoice. The data from Part (the part number) is used as the key to find the proper record on the inventory file (whose key is the field called Partno).

Column Key-From—If the lookup operation is to extract values from a column line on the secondary form (i.e., from the Quantity Price-Break Table), the system must know the item on the primary form that will supply the value to be searched for. This is Qto (quantity ordered) on the invoice.

Lookup-Column1,2, Interval Search—This is an either/or set of fields, by which the user identifies which of the three available column-search options the system is to perform (match, first line exceeding value, or range between two columns). In the invoice/inventory example, the system searches the item called Qty on the secondary form (the inventory) for a value equal to or greater than the value of Qto.

In the Transfer List, at the bottom of the form, the system finds these instructions:

Lines 1 and 2 transfer data to the primary form. The second column (headed "@") specifies the direction of transfer.

Line 3 checks to see if Qto is less than or equal to that Onhand. If true, the next three lines are skipped; the quantity Onhand in the inventory is reduced by the Qto (Line 7), and the value in Qto is moved to Qts (quantity shipped) on the same form (Line 8).

Lines 4 and 5 apply if Qto is greater than the quantity Onhand. They instruct the system to add the Qto to Backordered on the inventory (Line 4), enter 0 in Qts on the invoice (Line 5), and skip the next two instructions (Line 6).

Line 9 saves the new information on the lookup form (inventory).

Testing the Design

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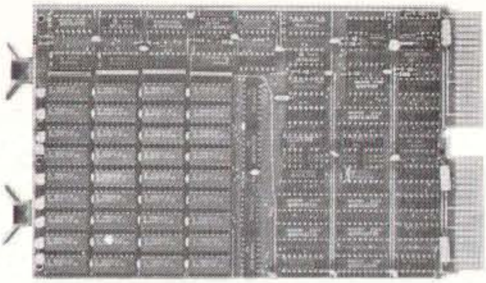

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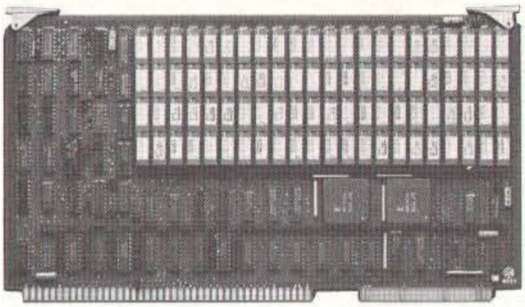

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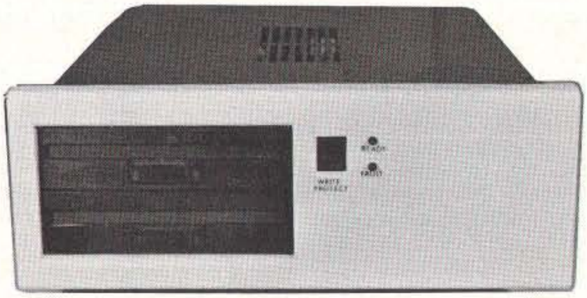

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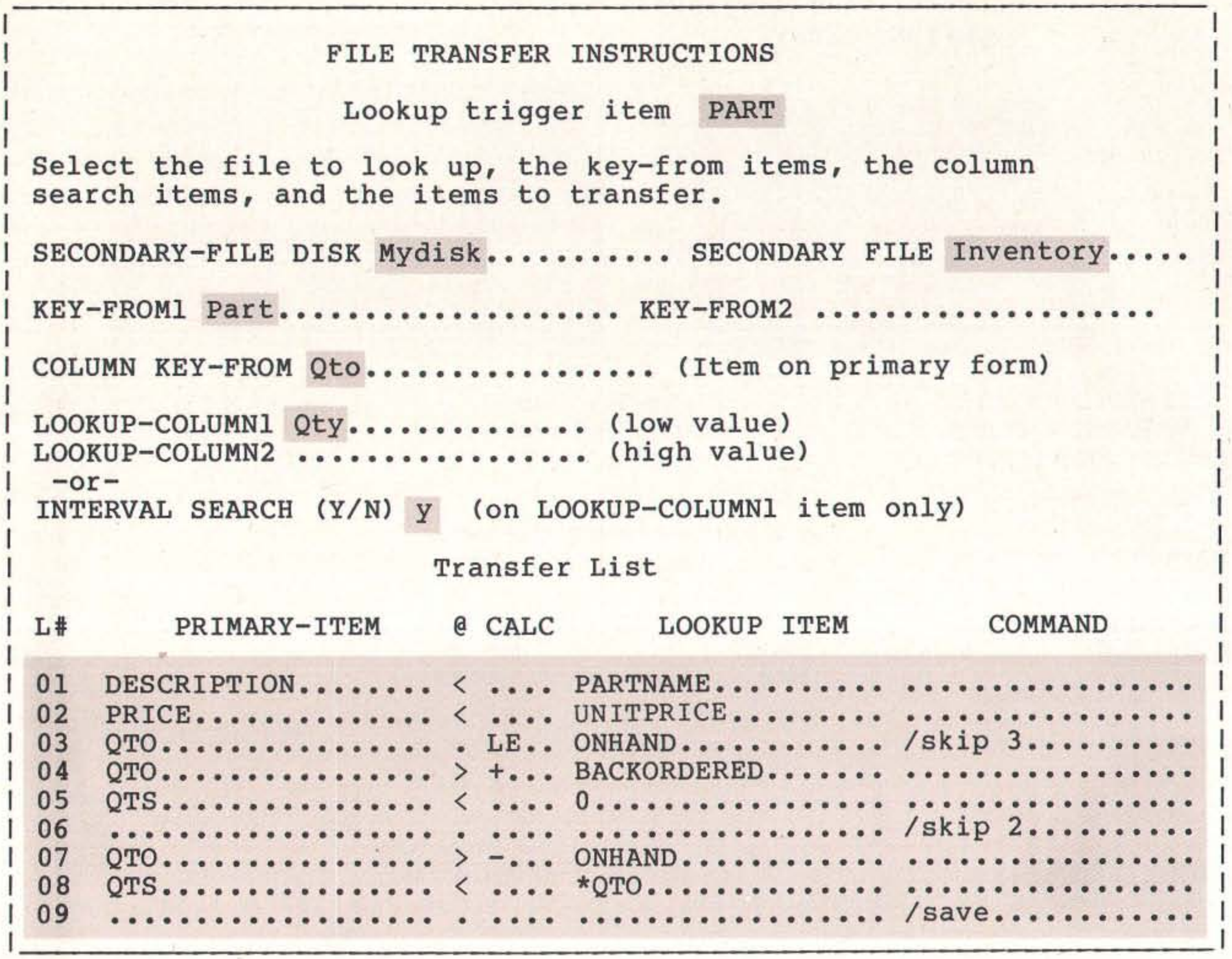

```
                 FILE TRANSFER INSTRUCTIONS

                  Lookup trigger item  PART

Select the file to look up, the key-from items, the column
search items, and the items to transfer.

SECONDARY-FILE DISK Mydisk........... SECONDARY FILE Inventory.....

KEY-FROM1 Part.................... KEY-FROM2 ....................

COLUMN KEY-FROM Qto................ (Item on primary form)

LOOKUP-COLUMN1 Qty.............. (low value)
LOOKUP-COLUMN2 ................. (high value)
 -or-
INTERVAL SEARCH (Y/N) y  (on LOOKUP-COLUMN1 item only)

                       Transfer List

L#       PRIMARY-ITEM     @ CALC      LOOKUP ITEM         COMMAND

01  DESCRIPTION........ < .... PARTNAME.......... .................
02  PRICE.............. < .... UNITPRICE......... .................
03  QTO................ . LE.. ONHAND............ /skip 3..........
04  QTO................ > +... BACKORDERED....... .................
05  QTS................ < .... 0................. .................
06  ................... . .... .................. /skip 2..........
07  QTO................ > -... ONHAND............ .................
08  QTS................ < .... *QTO.............. .................
09  ................... . .... .................. /save............
```

Figure 2: *The first attempt at design of an on-screen form for the invoice/inventory example shows user-entered instructions in tinted areas. This arrangement proved to be too complicated for easy user acceptance.*

the new feature would appear to users at this stage, a first draft of user-directed documentation was written from the specifications and circulated to reviewers. It served to inform those familiar with Versaform about the purpose of the new feature. The invoice/inventory illustration offered a simple example of how and why it would be of value to them.

In addition to the descriptions of fields on the File Transfer instructions in figure 2 similar to those just given, the documentation contained an explanation of the columnar area of the Transfer List form. We expected the reviewers to absorb these concepts:

The @ symbol, indicating the to-or-from direction of the transfer, has three legal options, or it can be left blank to signal either no data transfer or to defer to a Command instruction.

The Calc column is used to specify calculations to be performed when transferring data, introducing the terms Target and Source to differentiate between the two forms involved.

The Command column is a catchall used for either commands, values, instructions, comparisons, or conditionals.

What we found, however, at this stage of development was that the File Lookup feature was a big lump for the reviewers to swallow and might, in fact, be indigestible. Before even the most basic of File Transfer operations could be managed, users were required to understand the differentiation between the two files involved, the trigger concept, two applications of key, and the variations in the column lookup operation involving one column or two, whether inclusive or not. In addition, a small glossary of programming terms was introduced.

Two Conceptual Steps

Our documentation and product-support staff identified two areas of confusion for nontechnical users.

First, the variations in the column-line lookup operation could not be clearly defined in the limited space available at the top of the form. More important, however, the variations were specialized; in simple applications where they were not necessary

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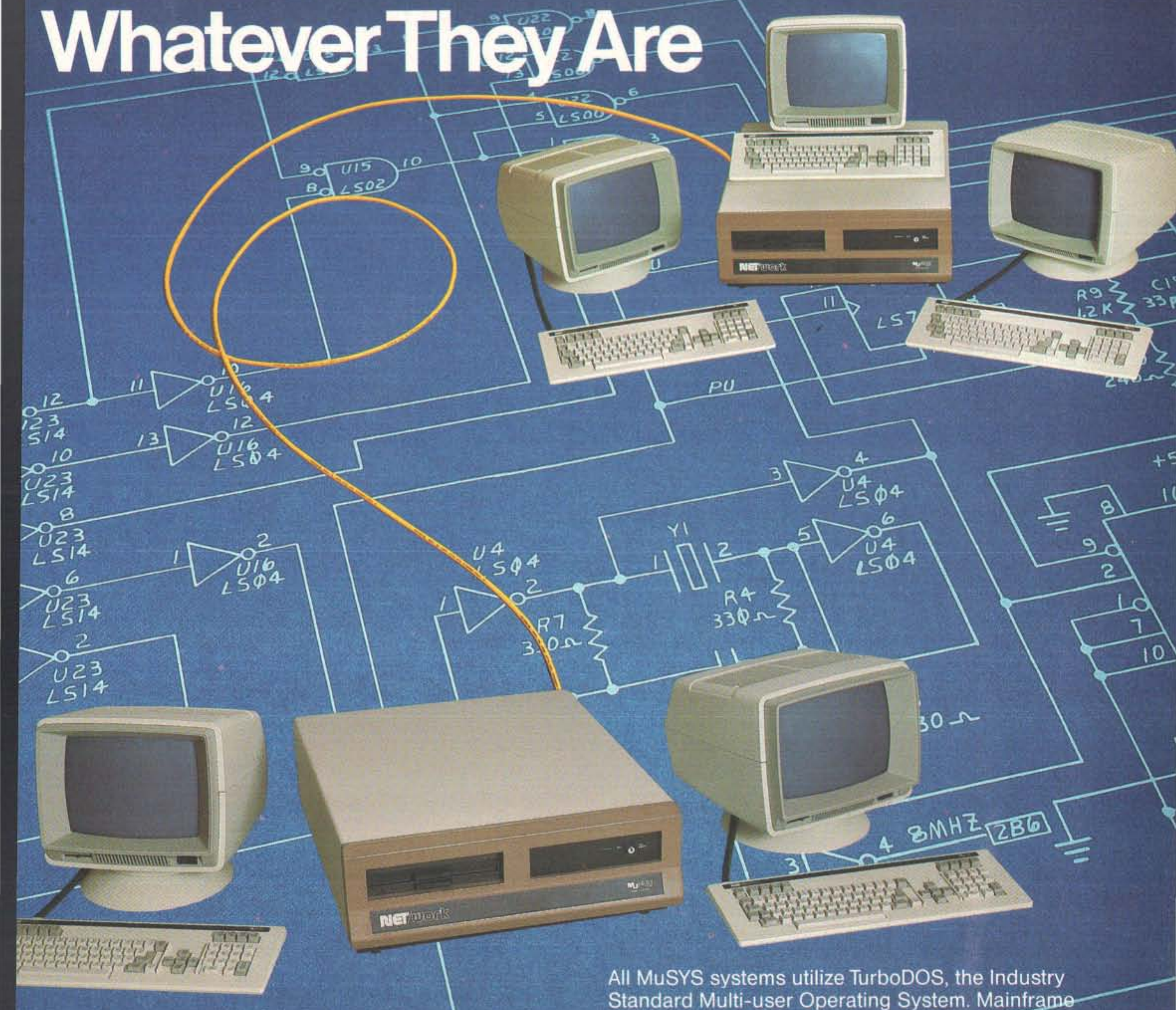

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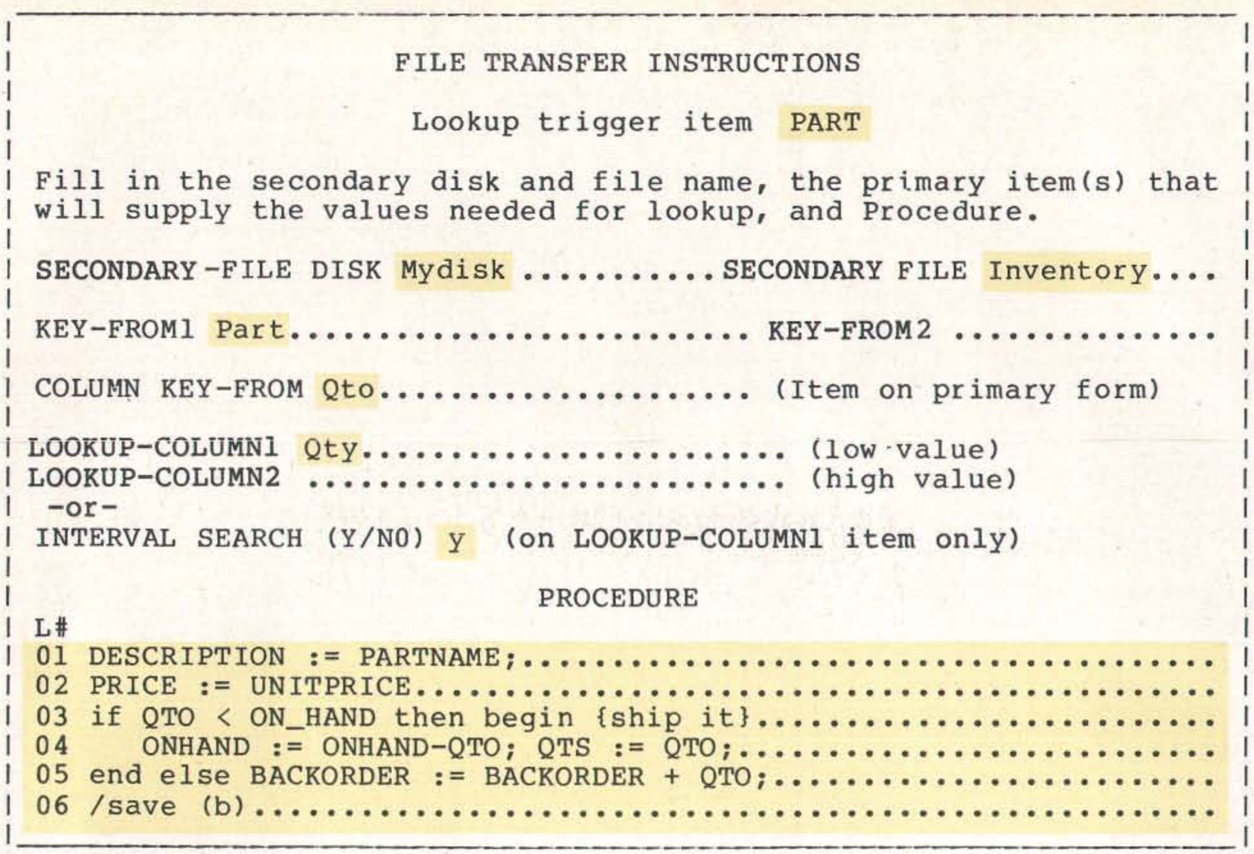

```
                    FILE TRANSFER INSTRUCTIONS

                   Lookup trigger item  PART

Fill in the secondary disk and file name, the primary item(s) that
will supply the values needed for lookup, and Procedure.

SECONDARY-FILE DISK Mydisk ...........SECONDARY FILE Inventory....

KEY-FROM1 Part......................... KEY-FROM2 ..............

COLUMN KEY-FROM Qto.................... (Item on primary form)

LOOKUP-COLUMN1  Qty....................... (low value)
LOOKUP-COLUMN2  .......................... (high value)
 -or-
INTERVAL SEARCH (Y/NO) y  (on LOOKUP-COLUMN1 item only)

                          PROCEDURE
L#
01 DESCRIPTION := PARTNAME;...................................
02 PRICE := UNITPRICE.........................................
03 if QTO < ON_HAND then begin {ship it}......................
04    ONHAND := ONHAND-QTO; QTS := QTO;.......................
05 end else BACKORDER := BACKORDER + QTO;.....................
06 /save (b)..................................................
```

Figure 3: *This revised form for the invoice/inventory example substituted procedural instructions in place of the Transfer List. This arrangement was a definite improvement over figure 2 but still required entry of seldom-used data.*

(e.g., where there is only one price for a part), they seemed to get in the way.

Second, the columnar area at the bottom of figure 2, the Transfer List, was versatile and flexible but decidedly unfriendly.

Our first revision attacked the problem of the Transfer List. Instead of a syntax made up of columnar entries, instructions to the system were now to be handled by procedural statements entered in more familiar syntax. The statements would resemble those of a programming language such as BASIC or Pascal. The revised form is illustrated in figure 3. It is filled in with the same system instructions that were given by the Transfer List method in figure 2. In this example, Description and Price (Lines 1 and 2) are to be assigned values.

The letters "a" and "b" designate which form the item is on; "a" is the primary form and "b" the secondary. These qualifications are necessary only in cases that would otherwise be ambiguous, as in the /save command (Line 6) or when items with the same name are on both the primary and secondary forms.

The if/else statements determine whether to ship or back order the product.

The Onion Approach

After we had the solution to one problem area, we were able to solve the second. The column lookup information (in figure 3, the fields Column Key-From, Lookup-Columns 1 and 2, and Interval Search) was still confusing and always had to be filled in, even though useful only in a minority of cases, such as in the Quantity Price-Break Table.

We decided that the information heretofore entered in these items could be handled as procedural statements. In this form, they would be available when required but wouldn't have to be understood by those who were not using the feature.

The four fields were summarily removed, and the resulting form was much easier to understand and use (figure 4). This opened the way to a new operational concept of the feature, which took the name the onion approach.

The outer skin of the onion comprises the basics. This might include the simple transfer of information, such as Partname and Stdprice in figure 1. This is the operation illustrated in figure 4. As users become more sophisticated in their use of the feature, layer after layer is peeled away, exposing some of the system's more complex capabilities.

Using this approach, the complexity of the operation does not intrude upon Versaform's basic nontechnical orientation. Users don't have to deal with or understand terminology or concepts beyond those needed at the time.

The procedure in figure 4 is filled in with the instructions that the user would give the system in the invoice/inventory example for two simple operations: the transfer of Partname and Stdprice information from the in-

Circle 328 on inquiry card. →

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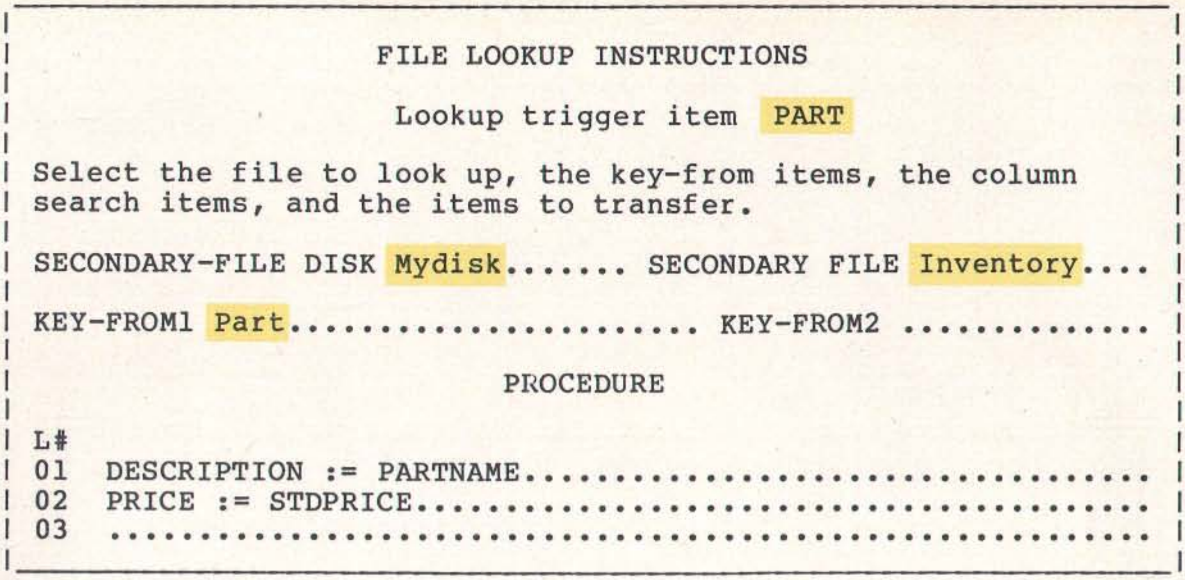

```
                    FILE LOOKUP INSTRUCTIONS

                    Lookup trigger item  PART

Select the file to look up, the key-from items, the column
search items, and the items to transfer.

SECONDARY-FILE DISK Mydisk....... SECONDARY FILE Inventory....

KEY-FROM1 Part...................... KEY-FROM2 .............

                           PROCEDURE

L#
01   DESCRIPTION := PARTNAME................................
02   PRICE := STDPRICE......................................
03   .......................................................
```

Figure 4: *The final form design removed the column lookup operation and substituted a built-in procedure that doesn't intrude unless accessed for special operations.*

ventory to the Description and Price fields on the invoice.

When Unitprice is needed, a built-in procedure (Find_Line) would be used to set the line number to find the appropriate line in the Quantity Price-Break Table for quantity ordered.

An Evaluation

The Transfer List method fit in nicely with Versaform's column-item structure and field-editing capabilities. However, the instructions took on an assembly-language appearance when burdened with the need for branching and error handling. There was no easy way to key in a meaningful error message in the space provided or to handle functions with more than one argument. We were sure that eventually the scheme would break down in a real-world application.

On the other hand, the procedure method required us to produce a language specification and define a set of built-in functions to take care of the lookup and column area search.

In effect, we created a "minilanguage" with a syntax similar to Pascal but with the simplicity of BASIC. This combination simplifies the handling of conditional execution and includes the flexibility to add more functions later.

The final design follows the onion approach, as does the documentation, presenting successive layers of complexity, starting with a File Transfer Instructions form and ending with the full syntax and functions available. Users can become thoroughly familiar with the elementary capabilities of the feature without having to understand the more advanced operations. Later, when requirements become more complex, the facilities needed are available in the form of built-in functions.

User perspectives are critical to the successful revision of product design.

The simplicity of the language is a result of those things taken care of automatically by Versaform. No data structures or data types need to be declared; the data structures for the primary and secondary forms are implicit declarations. File I/O (input/output) and storage management are built in. Data conversion is handled automatically, and exceptions are dealt with by ignoring missing or invalid data in computations and flagging the error to the operator.

File Lookup is now a part of the Versaform system. Although it was a difficult feature to design, it is compatible with the other programs in simplicity of operation and documentation.

Concepts in Development

The evolution of the new feature made us aware of two especially useful concepts in the design of new enhancements.

Much can be said for the drafting of documentation before the design is frozen, to test user perspectives and to work out revisions that will enhance the product from the user's point of view. At this point, the documentation will often drive the design. Put another way, if you can't document it simply, don't code it!

In addition, the onion approach has proven to be one of the best devices for making advanced functions accessible. A feature that seems overwhelming in its entirety becomes manageable when its complexities are hidden beneath layers of simple and familiar operations. These layers, peeled away as needed, build on a user's comfortable and gradually increased understanding.■

Joseph Landau is president of Applied Software Technology (170 Knowles Dr., Los Gatos, CA 95030).

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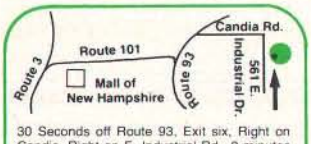

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Pascal Graphics Editor	100	75
Southeastern		
Data Capture Videx	90	65
Southwestern Data		
ASCII Express Professional	130	89
Printographer	50	38
Zterm Prof.	150	109
Videx		
Videoterm Utilities Disk	37	28
Visicorp		
80 Col prebook/Apple	29	21
80 Col prebook/Visicalc	49	27
Soft Video Switch	35	25
Visiterm	100	79
Visitrend/Plot	300	195

APPLE III™

Visicorp	LIST	SALE
Business Forecasting Model	100	78
Visischedule	300	195
Link Systems		
Data Fax	249	187
Software Publishers		
PFS: File	175	129
PFS: Report	125	79

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Software Publishers		
PFS: File	125	85
PFS: Graph	125	85
PFS: Report	125	79
Visicorp		
Visicalc	250	159

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Micromodem II	379	259
w/Term Pgm	409	289
Kensington		
System Saver Fan	90	69
Kraft		
Joy85ck	45	
LJK		
Lower Case Char Gen	25	19
Microsoft ®		
16K RAM Card™	100	69
Premium System™ [5]	695	489
Softcard™	345	219
New Premium Card™	495	369
Personal Computer		
Applicard (6MHz)	375	305
TG		
Joystick	60	45
Videx		
Enhancer II	149	99
Ultraterm	379	279
Videoterm with Softswitch	375	239

CP/M

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Business

ATI	LIST	SALE
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Ashton-Tate		
Bottom Line Strategist	400	269
Aspen		
Grammatik	75	56
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Palantir	425	299
Dictronics		
Random House Thesaurus	150	102
Digital Research		
Display Manager	400	295
Epic		
Supervyz	150	94
Mark of the Unicorn		
The Final Word	300	199
Mince	175	127
Metasoft		
Benchmark Mail List	250	182
Word Processor	500	299
Micro Pro		
Calcstar	145	96
Mailmerge	250	129
Spellstar	250	128
Starindex	195	150
Word/Mail [5]	695	347
Word/Spell [5]	695	347
Wordstar Prof. (Word/Spell/Mail) [5]	845	395
Wordstar [5]	495	248
Microsoft ®		
Multiplan™	275	169
Multitool Financial	100	69
Multitool Budget	150	109
Northwest Analytical		
Starpak	495	369
Oasis		
The Word Plus	150	105
Punctuation & Style	129	99
Organic		
Milestone	295	229
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Select Word Processor	595	329
Sorcim		
Supercalc	195	115
Supercalc 2	285	159

Database

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Ashton-Tate		
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dBASE II w/user's guide	729	409
Friday	295	198
Caxton		
Cardbox	245	177
Condor		
Condor 3	650	395
DJR		
FMS 80	395	275
Digital Research		
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FYI		
Superfile	195	112
Fox & Geller		
Quickcode	295	175
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dGRAPH	295	190
dUTIL	99	58
Human Soft		
DBPlus	125	95
Micro Pro		
Infostar	495	327
Microsoft ®		
Sorting Facility (MSORT)™	195	151
Pearl Soft		
Personal Pearl	295	221
T/Maker Co.		
T/Maker III	275	215

Home/Education/Games

Infocom	LIST	SALE
Deadline	60	43
Starcross	50	38
Zork I	50	38
Zork II	50	38
Zork III	50	38
Suspended	50	38
Supersoft		
Dungeon Master	40	30
Nemesis	45	34

Language

Digital Research	LIST	SALE
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CBASIC	150	94
PL/1 80	500	375
Pascal MT+	350	262
Pascal MT+ with SPP	500	395
RMAC	200	150
SID	75	63
ZSID	100	88
Microsoft ®		
Basic 80 Interpreter	350	249
Basic Compiler	395	285
Cobol 80	750	562
Fortran 80	500	345
MACRO 80	200	150
μLisp/μStar	200	156
Supersoft		
ADA Compiler	300	225
C Compiler	250	188

Utility/Comm/Graphics

Byrom	LIST	SALE
BSTAM	200	149
Digital Research		
Despool	50	38
Microstuf		
Crosstalk/Smartmodem	195	117
Supersoft		
Disk Doctor	100	75
Woolf		
Move It	125	83

HARDWARE, NOT MACHINE SPECIFIC

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Hayes Microcomputer Products		
Chronograph	249	199
Smartmodem 1200	699	499
Smartmodem 300	279	209
NEC		
Monitor 12" Green Hi-Res	285	167
Novation		
J Cat	149	119
Smart Cat 103	259	207
Smart Cat 103/212	595	476

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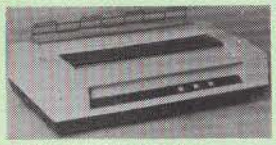

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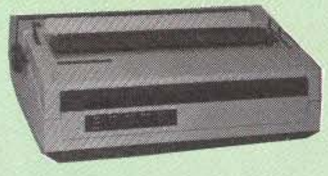

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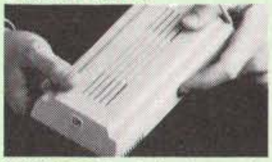

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The Future of Metaphor in Man–Computer Systems

User interfaces from digital watches to digital computers

by Chuck Clanton

In the last few years, I have owned a succession of digital wristwatches. From the first moment I saw one, I knew it was functionally the same as my old Swiss 14-jewel analog watch, but somehow quite different. Interestingly, while the two are recognizably similar, they share almost nothing in visual appearance, the number and type of the controls, and the mechanism inside. They share only a single function, telling the time. Even the way they tell the time is quite different. My Swiss watch did so with a picture; a quick glance would give me a sense of what time it was. My new digital watch uses numeric language, which must be read—a process that is slower but much more accurate.

Why is this new object immediately recognizable as a watch? A microwave oven does not resemble a cooking fire, nor does an automobile recall a horse. A computerized accounting package is radically different from a set of bookkeeping ledgers and journals. The digital watch may not be an exact functional replica of its mechanical predecessor, but I immediately knew that this new device was a watch and that I could expect it to perform certain tasks. Evoking this sort of inference from any product of a new technology is critical to its acceptance. The next step, of course, is to find a device that is easy to learn and use.

Documentation: Explicit and Implicit

Though my first digital watch had four buttons, it had more than four functions. Unfortunately, I never could discern any logic to the use of these buttons in controlling the watch's functions. For example, the way the alarm was set and the way the time was set were completely different. At the end of several months of ownership, I still had not learned how to use all of the features without going back to the owner's manual. One day I could no longer find the manual, so I threw the watch away and bought another. Admittedly, I am an unusual consumer. I actually do read instruction manuals and even have a file folder where I keep them. Of course, that folder contains many manuals for gadgets I no longer own, and the folder occasionally refuses to disgorge the manual for the device that is bedeviling me at the moment.

When you are designing the interface for *any* device, you just cannot assume that your user has access to the manual. Even if the manual can be found, it probably will not be read. Training programs are no cure: if they're not completely misguided, they may help the original users, but what about all the other people who follow? The solution lies in the design of the device itself and how it interfaces to its user. The interface designer must take responsibility for the "learnability" of the interface. Paradoxically, the better the interface (i.e., the more the system fits what the user expects), the less documentation is needed, so nuances described in the manual tend to be overlooked.

My next digital watch had a few more functions and no more buttons. I was somewhat smarter, however, and found a watch interface that was easier to understand. The buttons perform functions in a more logical fashion, and the currently selected function is indicated on the face. One button selects from among a small number of functions, and another chooses among various options for that function. Hence, the total number of functions is rather large, but they're easy to remember because they are logically categorized.

Mechanical watches use a rotating stem to set the time. In my digital watch, two buttons accomplish the same task, one to increase and the other to decrease the setting. These same two buttons are always used for setting times, whether for the current time, the 24-hour alarm, the second time zone, the count-up timer, or the count-down timer. I never finished reading the user's manual, so it probably is still stowed in my instructions folder.

Inherent "Watchness"

How is it that the digital watch gained the immediate benefit of recognition? Why did I assume that I knew its fundamental capabilities, even in the face of the first, terrible interface. And what critical features made the second interface so much better? Somehow, this new device seemed familiar. It impressed me with its similarity to my prior experience with watches, and this similarity made it possible for me to infer the existence of functions and controls from that experience. Fortunately, those inferences proved correct, so that I quickly gained confidence in my mastery of the new technology.

If I were to write a manual for a digital watch, I might well try to ease the reader into this new technology by pointing out how the digital watch resembles the mechanical watches of the past. An explicit comparison or *simile* in my digital-watch manual would not limit the new device to be just like the old but would create expectations from the reader's experience with the old. On the other hand, a *metaphor,* which makes a comparison without the use of "like," produces a stronger inference of similarity, even though the reader knows the two objects of the metaphor are not truly identical. In a user manual, prudence dictates the use of simile to avoid overemphasizing the similarity.

However, I am not writing a manual for a digital watch, and in fact I'm not interested in writing manuals at all, because most people do not read them until hopelessly confused. *The device should document itself.* It should create the metaphor that directs its use, then give feedback that allows the user to learn more. Just as with the digital watch, the metaphor can be vague and inexact, so long as it helps the user understand what the device is and how it may be used.

The watch metaphor for the digital timepiece was instructive enough so even the bad control interface did not make the watch unusable. I was confident that I knew what it was and what it could do. Of course, this confidence meant that I blamed the first watch for my lack of understanding. Interestingly, when you know to blame a new device for its faults rather than yourself, the overall design is strong. I have no doubt that it is my toaster's fault when I burn myself often on its overly hot handle. I know how a good toaster should work. Most users blame themselves when a computer system does something nasty and unexpected because they do not have enough experience with systems that work well for them—not enough computer systems are designed well enough for them to know.

The total number of functions is rather large, but they're easy to remember because they are logically categorized.

Computing Machines

By now, you may be wondering why an article on future metaphors for computer systems has spent so much time discussing digital watches. If you think of a computer as a *means* rather than an *end,* than the relationship may be clearer. The vast majority of all computers manufactured in the future will not be enthroned in homes and computer centers with programmers in attendance. Most computers will be dedicated to specific tasks deemed important to those outside the computer priesthood. To prove my point, look at the distribution of computers today. Sure, I have several microcomputers in the computer system in my study (one in my video-display terminal, one in my printer, one in the tape-drive controller, and of course in the central processor). I also have microcomputers in my washing machine, my microwave oven, my furnace thermostat, my fire alarm, my two calculators, my digital watch, and probably a few other places I have not yet discovered.

Most people will never be programmers, but they will want the services of all the devices spawned by this new technology. These people will not be interested in learning how to get at these services through the operating system of a general-purpose computer, and indeed they will not really care that the computer makes these services possible. All that will be hidden away, just as it is in the microwave oven and digital watch. This is not a change or new direction for computers. Throughout the history of computers, their greatest strength has been the program's ability to create an abstract machine to fit the user's model of the computer's task.

The computer was aptly named because its original conception was as a mechanism for computation. Given this view of the machine as a "computer," FORTRAN was one of the most significant early transformations of the machine to match the user's task. It did so by providing an "abstract machine" for algebraic formula translation. Using FORTRAN, you could write algebraic expressions in a much more natural and convenient way than you could in assembly language. The machine became an *algebraic-expression processor,* an abstract machine that understood algebraic expressions the way its users did. Unfortunately, algebra does not include a model for control, since people evaluate each set of con-

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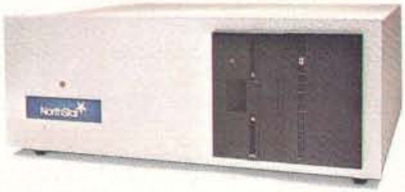

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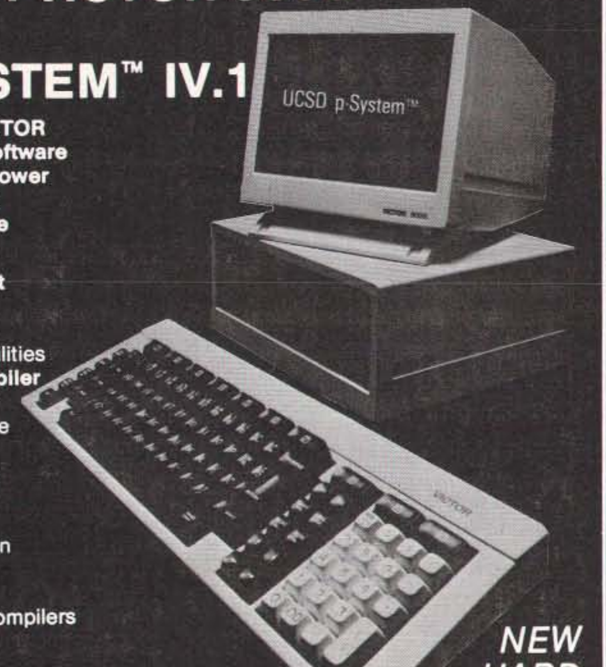

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ditions and decide the next step. Today, FORTRAN is justly criticized for its lack of good control mechanisms. Yet its algebraic model for computation has been propagated into most languages since that time because of its success in matching our expectations about computation.

Our inferences based on our experience with algebra are not entirely correct—the difference between "real" arithmetic and "floating-point" arithmetic has bitten many of us more than once, and most new learners have at least some problems with the "assignment" statement. Nonetheless, the introduction of FORTRAN was a significant step in making the machine match the needs of its users. Since that time, the audience for a "computing machine" has become far outnumbered by those desiring services that are not computational.

The Linguistics of Use

Programming languages have become the tools for implementing these services and have proliferated to best support development of different applications with different characteristics. As a result, programming languages have also become increasingly removed from the most common users. Today, the most common computers are dedicated to specific functions: buried inside microwave ovens for control, inside calculators for complex calculation, inside telephones for remembering phone numbers, and inside digital watches for side effects of very simple arithmetic and memory.

In many ways, the digital watch seems the archetype of the future for computers—replacing devices and procedures that have serviced our needs less well and creating new needs by extending our capabilities. Who knows or cares what language was used to program the computer in the microwave, the calculator, or the watch? Certainly not the audience for whom these products are intended.

The proliferation of the personal computer has created the expectation that many existing tasks can be supported more efficiently and more ex-

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uberantly by this new generation of computers. What has been called the personal computer "revolution" will appear, historically, to be only the initial call to arms. This movement reflects the dramatically changing economics of digital electronics and promises a new era of products that better support our information-processing activities.

Microcomputers

When single-chip microprocessors first appeared, the potential power and economy of this emerging computer hardware was soon recognized. Home-built computers with 256 bytes of memory and no nonvolatile storage began appearing in surprising numbers. The computer itself cost very little, though in this form you could do little with it. Despite rumors to the contrary, we have not come very far since that time—not when you consider the potential penetration of this technology into our lives.

Certainly, the small, general-purpose computer has come of age. There is now software to support most of the obvious uses of such a system in the home and business. And those of us in the computer fraternity feel satisfied that much has been accomplished and that much of what we wanted is now available. The rest of the world will just have to learn some of what we know so people can pick the right software, find the best hardware to run it, and figure out the obscure incantations necessary to make it all work. You often hear us make comments like "Ignore that bug; it doesn't matter most of the time" and "Yes, that's confusing, but I can tell you what it means."

We are deceiving ourselves. People do not really care about the computer revolution any more than they care about any other item on the front page of their newspaper. Interested? Yes. Involved? No. Nor do they want to learn what is needed to use these miracle machines. They just want the miracle itself.

For now, we can force them to join the fringes of our fraternity because it's the only game in town. However, when a product appears that does what people want without all that elitist computerism about it, the market will prove that the users will buy what most directly satisfies their needs. An electronic accountant need be no more tainted by the presence of a microcomputer chip than the electronic typewriter or calculator has been.

People are already doing most of the tasks that they want and need to do. New products must solve the same problems but with better service and in a better way. My digital watch tells time, but not in the same way as its predecessor. It also reminds me of the passing of time with an hourly chime, like the old grandfather clock in my hall. It times parking meters for me so I do not have to try to calculate how much time I have left. When I travel, it tells me both the local time and the time back home so I no longer call the office at 6 a.m. This digital timepiece is only metaphorically the watch of my past experience. That is just the starting point for my understanding of it.

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From there, I have learned many new functions of time that I now relate to the concept of "watch." A study of the U.S. population of watch buyers would probably reveal an almost universal shift in the concept of "watch" due to this new product. The shift in expectations is little noticed because the metaphor provides continuity with our past experience. As control interfaces improve, it becomes easier to learn the new services these new machines provide, and the change in the sophistication of their users accelerates.

Metaphors

By now it should be apparent that the ability to infer from prior experience is critical to the human interface of these new "miracle products." To understand these metaphors and how they will evolve in the future, let's view them from the perspective of the type of service they must introduce.

A metaphor can make the function of a machine be more compatible with its user's view of the task, what is here called a *functional metaphor*. Our example, the digital watch, is built to look and act similar in many ways to its mechanical predecessor, so that we immediately assume certain operations will be available. Metaphors can also be used to unify sets of operations (*operational metaphors*), so that we have expectations about what is available and how to use those operations. Possibly the oldest of these is the computerized workstation, which implies that the computer has all of the operations present in the physical workstation that preceded it.

Unlike the operational metaphor that emphasizes functions, the *organizational metaphor* focuses on how people use the *location* and *distribution* of the information at their disposal to identify priority and categorization. (The In box and Out box on my desk are simple examples of how location can categorize information.) Finally, the *integrating metaphor* allows separate products to share a single conceptual model, much like the filing cabinet and the typewriter assume the same physical dimensions of the piece of paper.

Functional Metaphors

I have created estimates for construction projects that used a spreadsheet with a series of interrelated tables for each subcontractor and class of material with amounts, unit pricing, and extended pricing. Inevitably, some amount or unit price must be changed, and changes must then be propagated through a number of other tables, which requires lots of erasure and is difficult to remember if the spreadsheet was not recently created. In frustration, I have often just thrown up my hands and fudged the final amount by a guess.

Then, Visicalc and its progeny were released. Without ever being conscious of it, I discovered that it was a product that I needed for years. Other tools were available to help with the spreadsheet problem, such as calculators for the computations and special paper to keep the columns neater, but here was the real thing: an electronic spreadsheet. This product "knew" what I was doing and helped me do it quite naturally. As soon as I used my first electronic spreadsheet, my world changed in a way that was perhaps more spectacular but no less fundamental than with my digital watch. No electronic spreadsheet that I have used seems just right, but the difference between having one and not is like the difference between a campsite with water and one without. I could never go back to pencil and paper again. For appropriate tasks, this product provides a very strong metaphor that closely matches my view of the task.

The match is not perfect. If it were, the electronic spreadsheet would be of little value. No paper spreadsheet allows you to instruct it in how the entries are related. Nor does it automatically refigure the values at your request. These and many other useful features of the electronic spreadsheet are new, but they are exactly what I had been waiting for.

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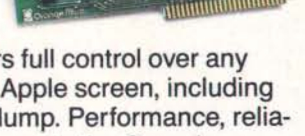

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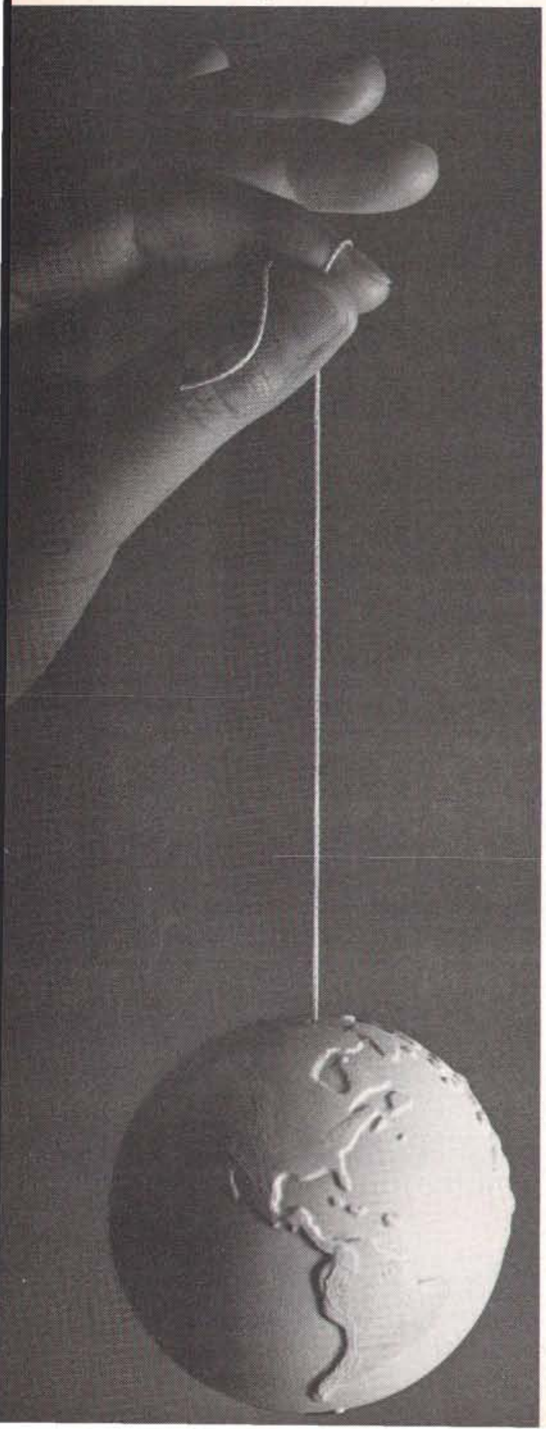

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DIGITAL MARKETING

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experience, but rather through eyes accustomed to the added functionality of the electronic spreadsheet. The perceptions and expectations of the people that make up this marketplace have been irrevocably changed because of the success of the electronic spreadsheet.

Operational Metaphors

The Xerox Star was a signal product that demonstrated the power of metaphor in the interface of an office workstation. This product and its progeny, including the Apple Lisa, use a desktop metaphor to provide a consistent interface to a system with office-automation functions. Because many of the concepts are new, each system has serious flaws, but it is much easier to see flaws when the whole has a consistency and integrity that highlights the problems rather than drawing one's attention away from them.

An interesting aspect of the user interface in these systems is the use of the mouse pointing device. This is obviously metaphorical, because you do not actually point with the mouse. The movements you make with the mouse are translated to movements of a cursor on the screen. The tight physiological hand-eye feedback loop reinforces the metaphor so well that it quickly becomes as natural as using your finger to point.

These systems package together a number of applications with a consistent style of interaction, using the mouse, overlapping screen windows, menus, and a *location-operation* syntax. This consistency has the advantage that it need be learned only once but the disadvantage that it forces all functions to share the same input and output concepts and mechanics. The functions themselves are distinct, and the desktop metaphor serves to suggest the presence and nature of the individual functions available in the workstation.

The sense of consistency in the interface of the various individual functions is gained because general-purpose operations are common to each of them. The number of operations is reduced because of their generality. Though "learnability" itself has not

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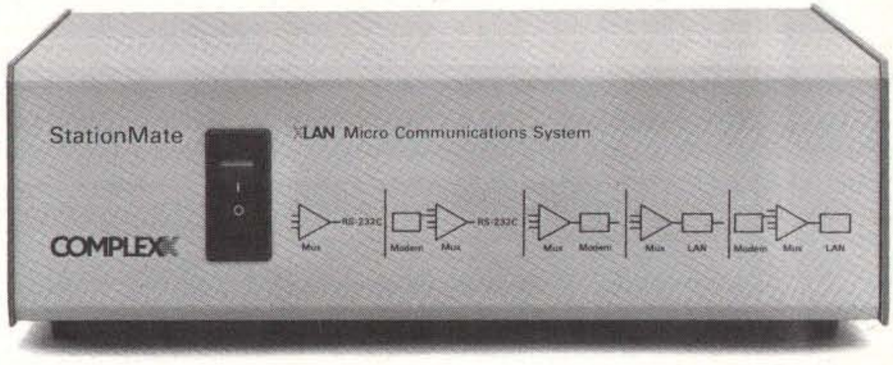

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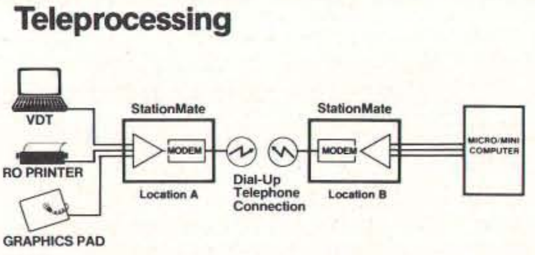
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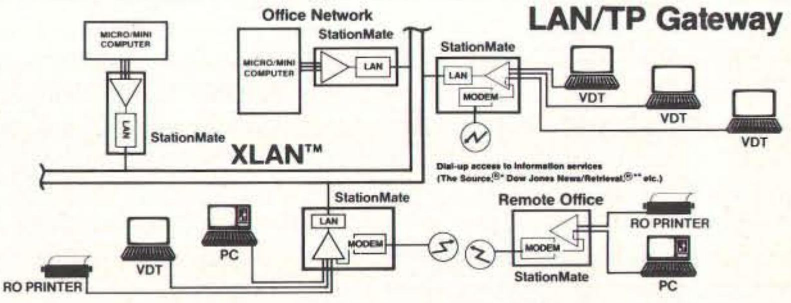
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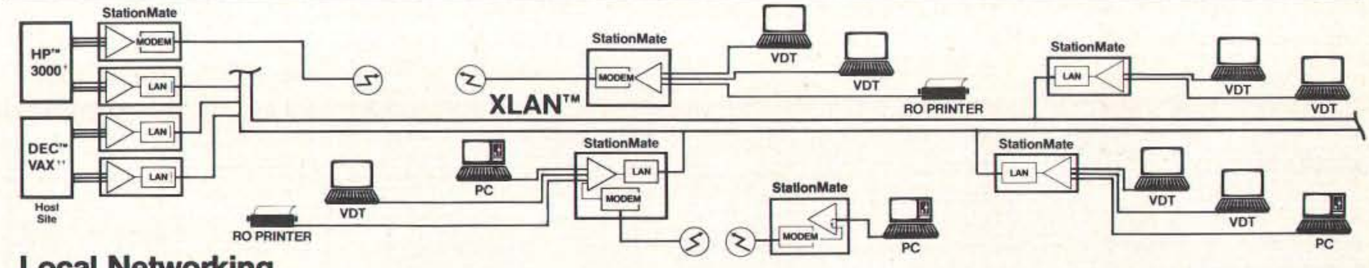
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been as well addressed as consistency, it is certainly enhanced by the small number of consistently applied operations.

This electronic desktop is certainly not like my old oak desktop—it offers its user both more and less. Many new services are provided that were either not available or not as simple without the computer. On the other hand, the actual physical piles of paper on a desk organize and advertise work in a way that is difficult to do on these systems.

Organizational Metaphors

The desktop metaphor has proven very appropriate for integrating a cohesive set of functions but less successful for modeling organization of work. There is more to organize than the long-term storage of file cabinets and software operators. Recent studies have just begun to give us insight into how people actually organize their work and use the files, drawers, and horizontal surfaces in their offices to create an entire organizational ecology. Each stack of papers on my desk has a different significance, and the visibility of the items in the stack serves to remind me of what I need to do.

As yet, I have not been able to replace these well-worn conventions by the facilities of any computer system, at least not with anything approaching the same immediacy and evocative power. Future computer systems will undoubtedly focus more attention on metaphors that include visual cues to assist my short-term and intermediate-term memory in the organization of my work.

Integrating Metaphors

A small but growing number of current software packages attempt to integrate several functions into a common framework. A database, word processor, and spreadsheet seem to be a common selection. Although most of these are integrated only in the sense that there is some access to each from the others and some uniformity of display and input mechanism, they share the same interface hardware. This visible integration in a single machine is primitive and transient. As the cost of digital electronics continues to drop, it will no longer be necessary to share one set of hardware across these many products. After all, each is compromised somewhat by the demands of the others on the interface and by the extra burden of learning how they relate and share the same hardware. As hardware gets cheaper, the user does not need to suffer these compromises or learn the level of common control that integrates these products.

To the extent that a single product, such as a word processor, needs access to spreadsheet and database functions, they should be included in the word processor itself. To the extent that it need share only information with other products, that sharing should occur magically without intervention from the user. Once this magic becomes commonplace, it will gain acceptance, and only its absence will be noteworthy. The products themselves do not need to appear to be shared. Each can have its own box, with its own input and display mechanism optimized for the tasks it performs.

After a short time, it will not be surprising that the results from the spreadsheet tablet can be displayed on the word-processor screen when needed, nor that the entries from the electronic sales order entry pad are available to the spreadsheet tablet and the inventory display instantly. This level of metaphor assumes the communication needed to share information—whether within or across products. The great burden of transporting data that mankind has carried since the first scribes, merchants, and bookkeepers will finally be lifted.

This distributed set of independent functional metaphors incurs less overhead than a single operational metaphor because functions have the support of implicit metaphors from prior experience with each of the separate devices replaced by its electronic counterpart. When your electronic phone and electronic telephone book can confer without direction from you, new forms of communication service become available. Once available, these services will rapidly become necessities.

The Future of User Interfaces

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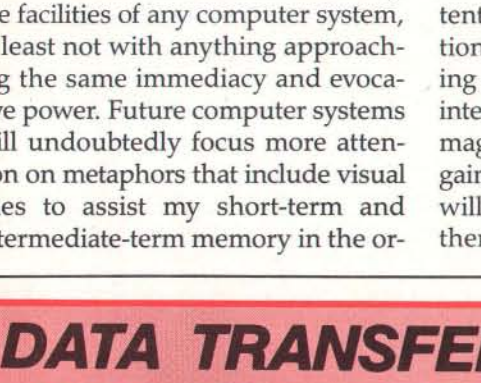

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Network technology that allows machines to communicate is coming of age. Various types of local-area networks and communication software are available, and the rich potential for interconnected groups of small computers is just beginning to be realized.

Input and output devices for increasing the bandwidth of communication between the man and the machine are evolving rapidly as well. These include pointing and drawing devices for input and bit-mapped displays for output. Much has been accomplished with voice input and output as well. Used appropriately, verbal communication can be very valuable: an electronic typewriter could benefit from voice recognition of commands to keep typists from having to move their fingers from the home row of keys.

Some people advocate full recognition of spoken language as the best input technology. Even when we have this capability, this would not be the ideal way to interface to many products. To assume otherwise is to overlook some critical properties of the man-machine interface. The complexity of the interface should ideally mirror the complexity of the task to be specified or controlled. So-called natural language is a complex and cumbersome communication tool. It is so difficult and time-consuming for us to say what we want that we often point to something rather than describe it. Pointing is faster, simpler, and less ambiguous. When people discuss even simple topics, much repetition and restatement is often needed before everyone believes an understanding has been reached. Even then, people are often wrong.

If you wish to control a light, a simple on-off switch is fast and efficient. The task is well matched to the control. Even sound-activated lights, the form of natural language without the substance, prove surprisingly subject to misinterpretation. Quiet contemplation of a new book is interrupted regularly by darkness, while inconsequential street noises waste electricity. Manual light switches are more certain.

Similarly, if I want to indicate a particular spot in my text in a word processor, I would rather point than talk. So-called natural language is more useful for those few occasions where the task itself is complex—for example, in database inquiry when the number of possible queries is very large.

Interface hardware is improving, and better hardware makes it easier and more natural to accomplish a broader range of tasks. Any product succeeds only if users can learn how to use it and decide it provides a necessary service. Better tools for communicating between the user and the product can do much to assure success. However, the design of the interface for these products must be firmly rooted in appropriately selected metaphors to promote learnability as well.

As interface designers, we sometimes defend our design with the premise that our system is designed to be powerful for the experienced user like ourselves and that obviously no system can be ideal for both naive and experienced users. Some preliminary experimental data in several areas suggest that this well-known trade-off is a myth. Several different types of studies have now shown that even experienced users prefer systems that are easy to use *and* powerful. We can build systems that are easy for the naive user, easy to learn and become an expert on, and powerful for the expert. Functional generality provides power that can be learned easily.

Learnability involves the ability of the user to quickly gain a conceptual mastery over the product that allows progress from simple initial exploration to more complex later uses. Learnability is the single most important concern in the interface design. This will be even more true in the future as products penetrate further into the market and further away from the computer fraternity. Meta-

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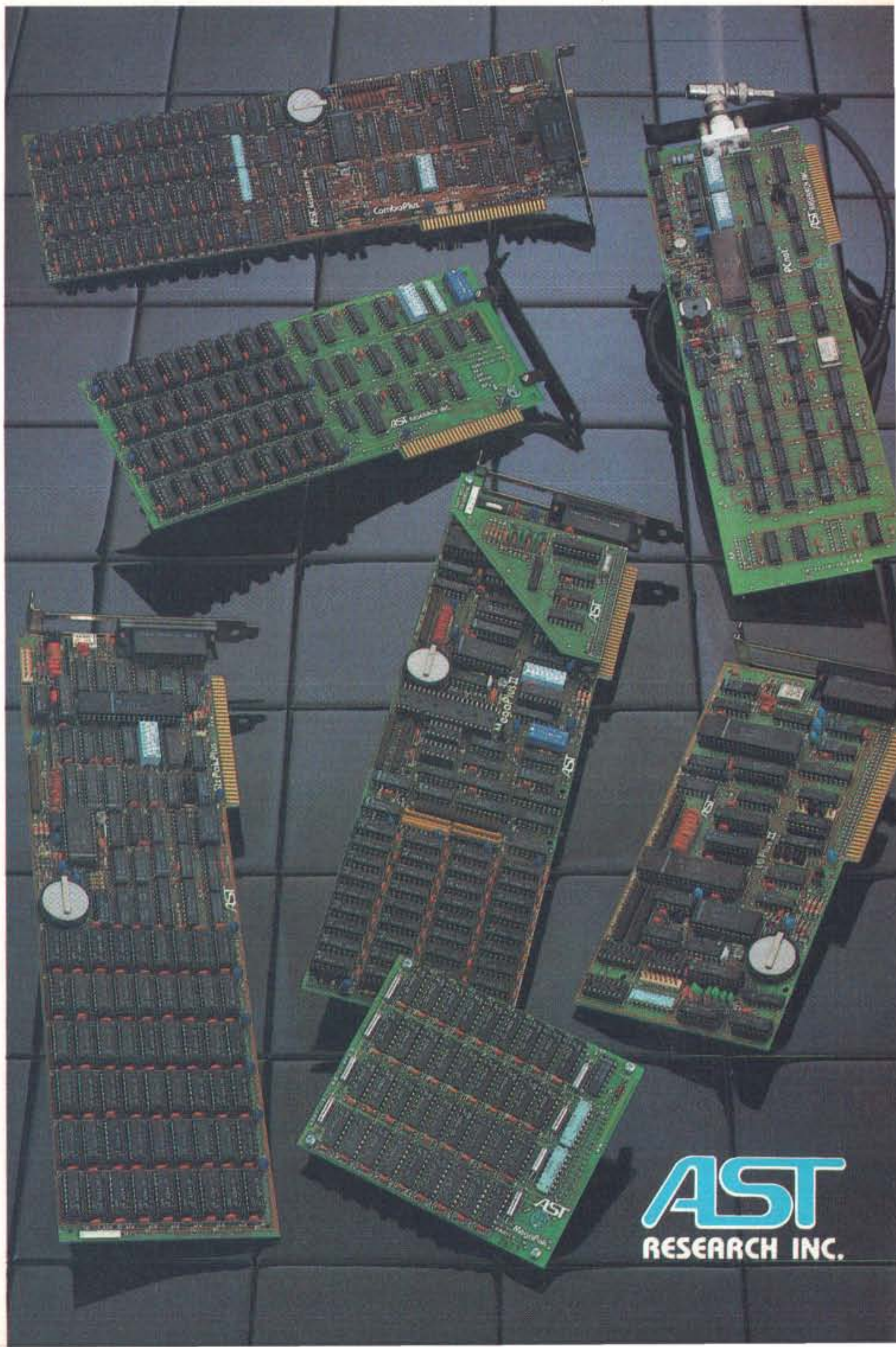

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phor provides the mechanism for gaining learnability by building up a user's prior experience. Consistency and generality are only necessary when they support the metaphor. If I have already learned an inconsistent way to undertake some task, learning a different, but consistent, way is harder than continuing with what I have already learned.

The methods and devices that help the user learn the product are still being explored—input devices that simplify giving information and commands to the machine, metaphors that increase the familiarity and inferability of the interface, and output devices that maximize the bandwidth of communication from the machine.

No one knows how to ensure learnability. Most current systems do not even use what little is known, but a select few have been carefully designed from a solid, if metaphorical, footing and have extended our knowledge considerably. Current research in the human factors of man-machine interfaces is uncovering basic information that is sometimes immediately useful and at other times is so simplistic that it's useful only as a basis for further research.

Good interface design is a dynamic concept because the exposure of our culture to computerized products is ever increasing. Just as the digital watch and electronic spreadsheet have changed our conception of the nature of watches and spreadsheets, other products have the capability to redefine the expectations of the users. To know your market, you must know an audience that is learning and changing all the time. As common experience accumulates, the metaphors to best serve a new product will change dramatically.■

Dr. Clanton (#4 China Basin Bldg., 185 Berry St., Suite 4821, San Francisco, CA 94107) holds an undergraduate degree in experimental psychology from Harvard University, a medical degree from the University of California Medical School in San Francisco, and pursued interdisciplinary doctoral-level studies in computer science and psychology at Stanford University. He has consulted in the areas of practical applications of the Unix Operating System, man-machine interfaces, and word-/text-processing applications.

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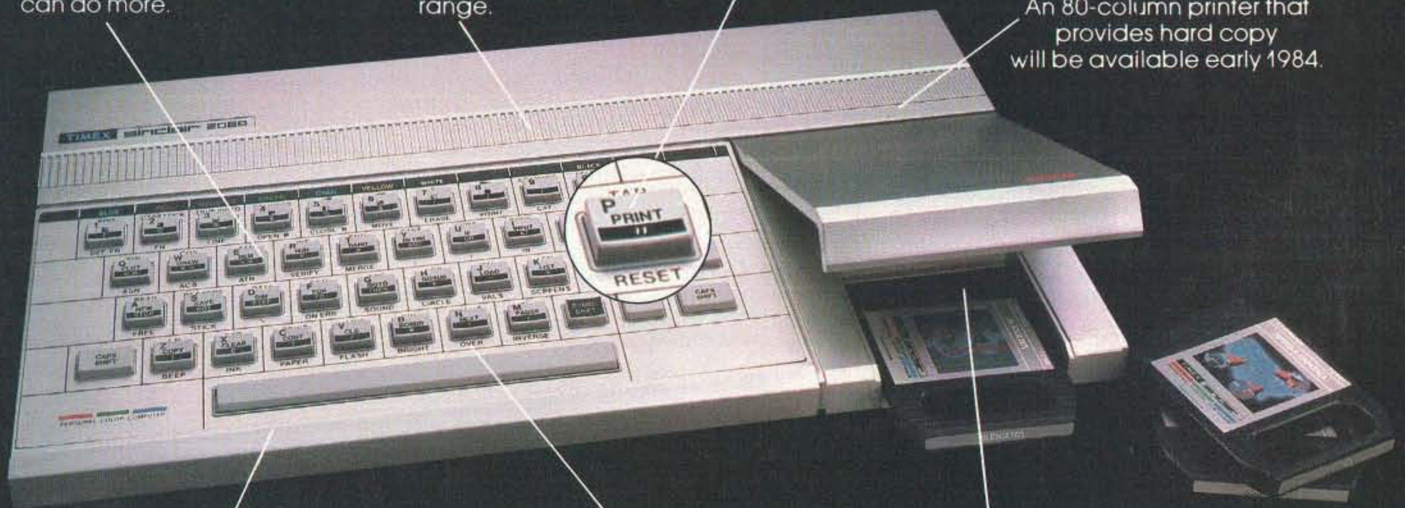

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Reviewer's Notebook

by Rich Malloy

[As I look upon the pile of cardboard boxes and three-ring binders where my desk used to be, one inescapable conclusion comes to mind: an awful lot of good products are out there. Of course, a few real turkeys lurk here and there, but most of the products that come to BYTE are close to being works of genius. The only thing that keeps them out of the computer Hall of Fame is the tremendous volume of similarly inspired products.

Every month, the question of how we should cover this deluge arises. We can do detailed product reviews of only a few products each month. But which ones do we choose? We have to briefly examine each product that comes in and then pick what look like the most significant or most interesting ones for reviews. Fortunately, some readers help us out by sending in reviews of good products that they have bought. The result is that most of the really significant products do get reviewed in BYTE—eventually. But, for some reason or another, a number of excellent products are passed over and never reviewed.

Even if a product does get picked for a product review, quite a bit of time may pass before the review appears in the magazine. This is partly because of the way reviews are written. Our reviewers are not full-time writers. Product reviews are usually done in the reviewer's spare time, a commodity that seems to be in short supply. And a BYTE review requires a tremendous amount of time. Reviewers have to examine all aspects of a product, not just those features that coincide with their personal interests. Reviewers then have to make a coherent, orderly, and interesting report of their findings. And that's only the start. Each review has to be checked for accuracy. It has to be edited so that it is even more coherent, orderly, and interesting. It has to be typeset, proofread, and assembled into an article, checked once more, transferred to a huge printing plate, and checked yet again. All this checking takes time, but as a result BYTE articles contain few mistakes.

For all those good products that may never get reviewed and for those readers who may not have time to wait for a product review and for that occasional dog of a product that should be duly noted, I've decided to initiate this semi-irregular page. It won't help lessen the pile of products that are on top of my desk, but who needs a desk, anyway? As long as I have my TRS-80 Model 100, a few batteries, and a reasonably comfortable chair, I'm in business.]

The DEC Rainbow 100

The best thing I've seen in the past few days is the DEC Rainbow 100 from Digital Equipment Corporation. You'd think that since BYTE is so close to DEC's headquarters, the company would be very quick in sending machines to us. No way. DEC moves very precisely, but very slowly, it seems. The Rainbow, however, seems worth the wait.

The Rainbow looks like a very slick package. It has two microprocessor chips (an 8088 and a Z80), a smooth-scrolling display, excellent documentation, and some nice touches such as thumbscrews on serial (DB-25) connectors.

But the Rainbow is no substitute for the proverbial pot of gold. Although CP/M and CP/M-86 were originally provided, MS-DOS was a long time coming. And—get this—until very recently you couldn't format your own floppy disks. You had to buy your floppy disks preformatted from DEC because "ordinary disks can't handle the high data density that DEC uses." Come on, guys, 390K bytes on a disk is not what I call super-high density. But fear not. Given enough time, sanity reigns. A disk-formatting program has just been released, but I haven't seen it yet. Remember that DEC moves very slowly. . . . Look for a review of this machine in a month or two.

Seequa's Chameleon

Another interesting product to finally come our way is the Chameleon from Seequa, a new company located in Baltimore, Maryland. This new portable boasts compatibility with the IBM PC, CP/M compatibility, graphics, and an incredibly low price of only $1995. That's just a bit more than half the price of an equivalent IBM PC.

Of course, when you buy a computer at a price like this you may have to forgo some incidental details. For example, our machine was lacking a user manual, and the printer port did not seem 100 percent reliable.

But rest assured that people at Seequa are very busy trying to iron out the kinks in their machine. They've promised to send us a newer, better version of it, and I'm sure they will. As soon as I see an improvement, I'll let you know.

Microsoft's Flight Simulator

The Microsoft Flight Simulator for the IBM PC arrived here a few weeks ago, and the entire BYTE editorial staff has been talking about Immelmans and inversions ever since. This amazing package does an incredible job of making you think you're actually flying a small plane. You can even crash into a simulation of Chicago's Sears Tower (great fun at parties) or land at O'Hare Airport. The package, by the way, also runs on the above-mentioned Chameleon and on the Corona when it is equipped with an IBM Color Graphics Adapter.

Good as it is, the Microsoft Flight Simulator would be even better if you could use it with an RGB (red-green-blue) monitor and a joystick, but for $49.95 you can't have everything. Go for a test flight at your local computer store. It's the cheapest (and safest) airplane you'll ever fly.■

Rich Malloy is BYTE's product-review editor.

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The Texas Instruments Professional Computer

Daring to be somewhat different

by Mark Haas

With everyone in the 16-bit world jumping on the IBM bandwagon—boasting compatibility, portability, and extended utility—it's a brave company that decides to strike out on its own and blaze a new trail. The Texas Instruments (TI) Data Systems Group reckoned that although it would have to contend with IBM's impact on the market, it could design a better machine. The engineers also decided that while compatibility was a desirable trait, it shouldn't get in the way of designing a better computer. Their efforts resulted in the TI Professional Computer.

Originally dubbed "Pegasus," the Professional Computer marks the Data Systems Group's entry into the personal-computer arena. This is *not* the same division that produced the 99/4A, now headed toward oblivion, but, rather, the group that has produced TI's more sophisticated minicomputers and terminals, including the ubiquitous Silent 700.

The TI Professional Computer is made up of three major components: the system unit, the display, and the keyboard (see photo 1). The system unit measures approximately 19 inches wide, 5¾ inches high, and 17 inches deep, and houses the main system circuit board, disk drives, and power supply. The standard display is a monochrome monitor; a color monitor is optional. The keyboard is, well, wonderful.

The System Unit

Out of the box, the Professional Computer is equipped with 64K bytes of main memory, one 320K-byte 5¼-inch floppy-disk drive, and a CRT (cathode-ray tube) controller card. The system unit provides space for another disk drive or a Winchester hard disk without adding an expansion chassis. Four expansion slots are provided for additional functions; the CRT controller board occupies a fifth slot; and a sixth, dedicated slot holds a memory card containing up to 192K bytes of additional memory, for a total of 256K bytes of main memory.

The system unit main board is the heart of the machine. It contains the 8088 microprocessor, a socket for an 8087 coprocessor, 64K bytes of 9-bit-parity, dynamic RAM (random-access read/write memory), memory control logic for addressing and refreshing the memory, 8K bytes of ROM (read-only memory), a socket for additional ROM, a Centronics-type parallel printer port, an I/O (input/output) port for the keyboard, a floppy-disk drive controller, five expansion connectors for the CRT controller and other options, one slot for memory expansion, timer chips, and a speaker. Photo 2 shows the system unit with its cover removed. Unfortunately, the disk drives obscure a total view, but the expansion slots and power supply are clearly visible. A block diagram of the system board is shown in figure 1.

Like IBM, TI abandoned its own proprietary microprocessors and based this computer on Intel's 8088 16-bit chip instead. In the Professional Computer, the chip runs at a clock speed of 5 MHz, compared to 4.77 MHz in the IBM Personal Computer (PC). TI makes no secret of the fact that its system will support an 8087 coprocessor. In fact, TI states throughout its technical documentation that the term "CPU" refers to both processors. The 8087 chip is still a bit pricy, but that probably will change with time, and TI is already providing Microsoft's FORTRAN, Pascal, and COBOL compilers that support this chip's extended commands.

In the "bottom-of-the-line" version, the 64K bytes of

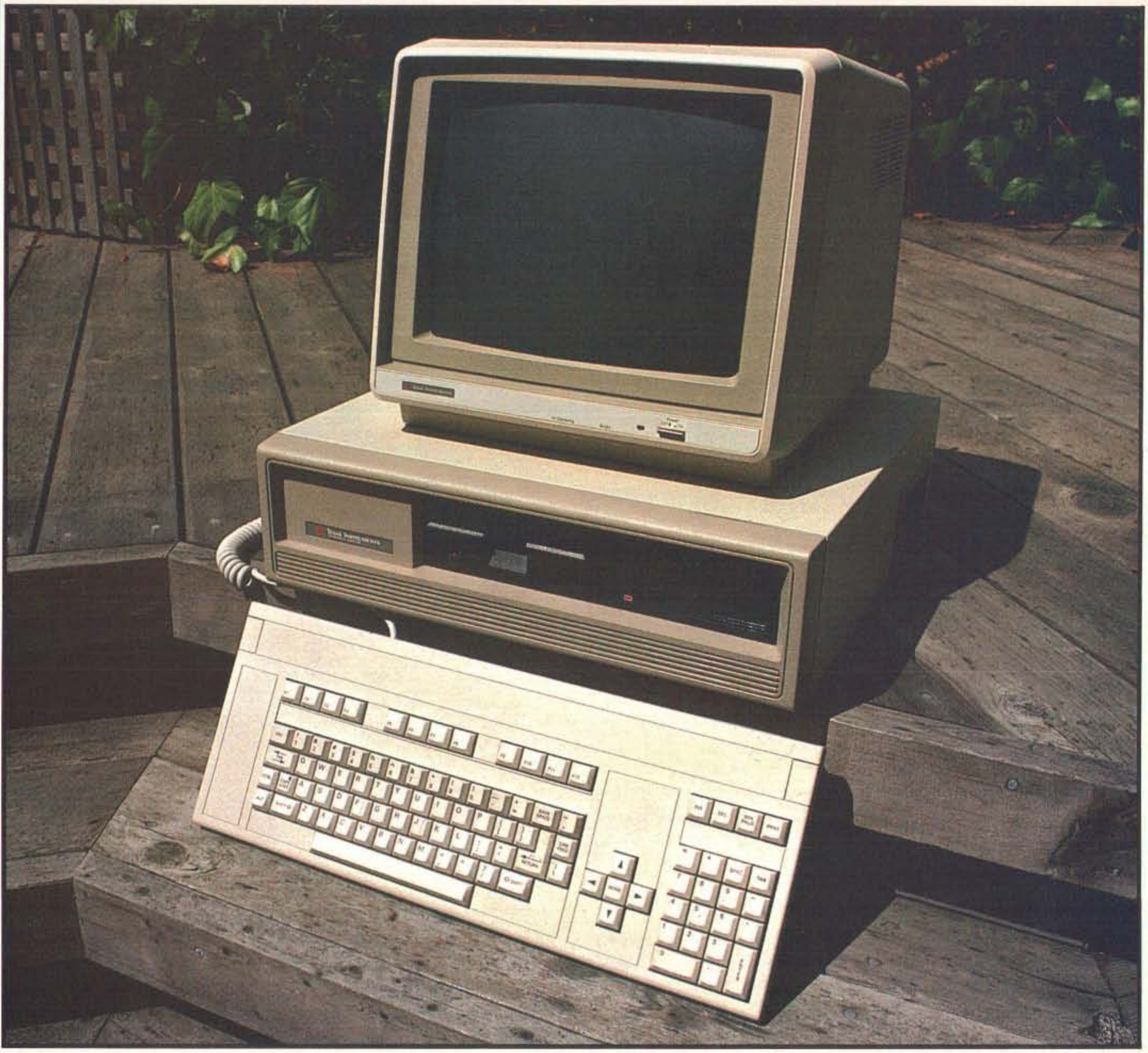

Photo 1: *The TI Professional Computer is made up of the system unit, the display, and the keyboard. This computer also has a 5-megabyte Winchester-disk drive installed to the right of the 320K-byte floppy-disk drive.*

9-bit RAM become nine chips of the 4164 type (64K by 1 bit), soldered directly to the system board. The optional memory-expansion board supplies 64K bytes of 9-bit RAM, and sockets can handle another 128K bytes of 9-bit RAM, bringing the total system RAM to 256K bytes. At first glance, 256K bytes seems to be the system limit, but a look at the technical manual shows the memory space from (hexadecimal) 40000 to BFFFF to be reserved for "expansion-bus memory." (Note: all addresses and machine-language instructions are in hexadecimal unless otherwise specified.) An additional 512K bytes can be installed through one of the remaining expansion slots, and TI is preparing such a board now.

The 8K-byte system ROM contains what are called "device service routines" for controlling the principal I/O devices in the system unit. The liberal use of hardware and software interrupts and software vectors, or pointers, enables a knowledgeable programmer to truly customize the use of the machine. These vectors reside in the bottom 1K byte of system RAM and can be changed to point to custom service routines. Through the use of these vectors, you could, for example, create any keyboard layout desired (Dvorak, anyone?).

The device service routines contained in the system ROM are directly accessible for system programming. They include routines for complete floppy-disk and Winchester-disk control (read a sector, write a sector, etc.), keyboard translation and buffering, speaker control, display and graphics control, and many more functions. Generally, these functions are implemented by

At a Glance

Name
Texas Instruments Professional Computer

Manufacturer
Texas Instruments Inc.
Data Systems Group
POB 402430
Dallas, TX 75240
(800) 527-3500

Components (base system)

System Unit
19 by 17 by 5¾ inches; Intel 8088, 16-bit internal, 8-bit external, 5-MHz clock; 64K bytes of RAM, expandable to 768K bytes; one 320K-byte, 5¼-inch floppy-disk drive standard; five expansion bus connectors for peripherals, one for memory only (six slots total)

Keyboard
Low-profile enclosure, 20¼ inches wide, 8 inches deep, 1½ inches high, full-width tilt elevator; 97 keys, Selectric-style keyboard, diamond-pattern cursor pad, numeric keypad, 12 programmable function keys; Intel 8048 microcontroller, 2400/300-bps data link to system unit

Display
Monochrome CRT, 18-MHz bandwidth; 80-column by 25-line display of 7- by 9-dot characters in a 9- by 12-dot cell; eight color characters (with optional color monitor), reverse-video, blinking, underlining, blank, and eight color attributes on a character-by-character basis

Software
System diagnostics

Options

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Color monitor, 19.2-MHz bandwidth	$695
300-bps internal modem, auto-dial, auto-answer	$295
300/1200-bps internal modem, auto-dial, auto-answer	$750
320K-byte floppy-disk drive	$475
10-megabyte Winchester hard-disk drive	$2295
One-plane graphics board (two colors)	$190
Three-plane graphics board (eight colors)	$325
Synchronous/asynchronous communications card, one serial port	$225
Memory-expansion card with 64K or 192K bytes	$300, $600
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MS-DOS operating system with MS-BASIC	$100
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CP/M-86 operating system with CBASIC	$240
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UCSD p-System operating system	$350
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MS-Pascal (with 8087 support)	$300
MS-COBOL (with 8087 support)	$750
Ryan-McFarland COBOL	$950 ($238 for run-time package only)
Multiplan	$250
Easywriter II	$350
TTY Communications	$60
3780 Communications	$150

Documentation
Operating Instructions manual

Price
Base system, $2195; full system (two disk drives, 128K RAM, monochrome monitor, MS-DOS, MS-BASIC), $3070; hard-disk system (monochrome monitor, 10-megabyte Winchester, 256K RAM), $5090

* price to be announced

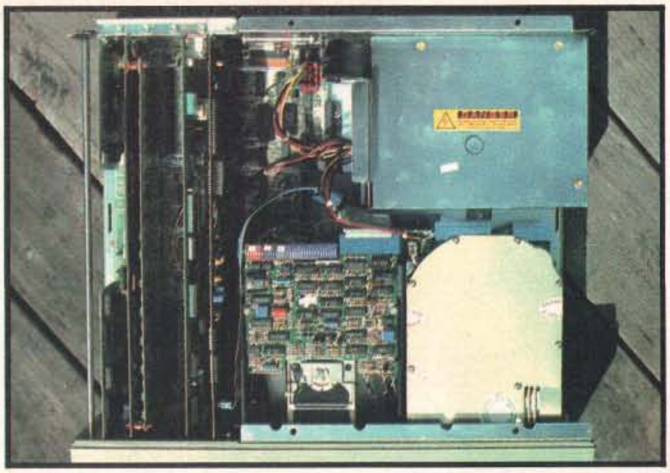

Photo 2: *Inside the system unit (the front is at the bottom) you can see part of the system unit board that contains the 8088 microprocessor, 64K bytes of RAM, a disk controller, a parallel printer port, and expansion slots. The memory-expansion board is located on the left side of the unit toward the front. From left to right: the expansion cards installed in this unit are the synchronous/asynchronous communications card, the CRT controller card with the video graphics card mounted piggyback on it, the 300/1200-bps auto-dial/auto-answer modem, and the Winchester controller card. The disk drives obscure a large portion of the system board. The power supply is located at the right rear corner of the unit.*

loading certain values into the 8088's registers and then performing a software interrupt. The interrupt causes the current program to cease execution, and control is transferred to a device service routine pointed to by one of the vectors located in the bottom 1K byte of memory. For example, if a value of 0 is placed in the 8088's AH register, and a value of 40 is loaded into the AL register, then the speaker will sound for 1 second when an INT 48 instruction is executed. By changing the vector in memory associated with the INT 48 instruction, you can cause control to be transferred to a custom routine.

Table 1 shows the various interrupt vectors. Note that the actual address of a vector can be determined by multiplying the vector number by 4. For example, the keyboard print-screen vector (called by interrupt 5E) would be a double word at 0:0178 (5E × 4 = 178).

The memory map (table 2) also shows reserved space for "smart" peripherals or option boards that contain ROM and are installed in the expansion slots. The review unit contained one of these boards, the Winchester-disk controller. This board contains its own 8K bytes of ROM that controls the operation of the hard-disk drive.

Unlike the IBM PC, the Professional Computer does not have to use a slot for a disk controller; TI placed it on the system board. Notice that TI's expansion bus is *not* compatible with the IBM PC's. Though at first glance all the address, data, and power lines are in the same places, a closer look reveals that the various control and interrupt lines are not. A full description of the TI expansion bus pin-out is provided in table 3.

The floppy-disk controller held a couple of surprises. The basic controller subsystem is the now-standard

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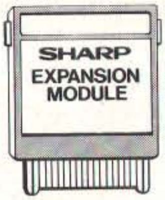

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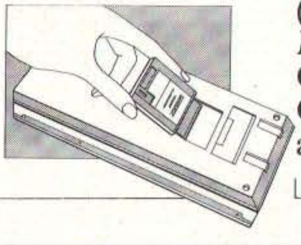
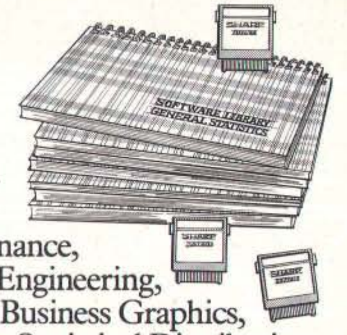


The PC-1500A also has a complete library of plug-in software programs including: Sharpcalc (Spreadsheet), Finance, Math, Electrical Engineering, Circuit Analysis, Business Graphics, General Statistics, Statistical Distribution and Graphics Development.



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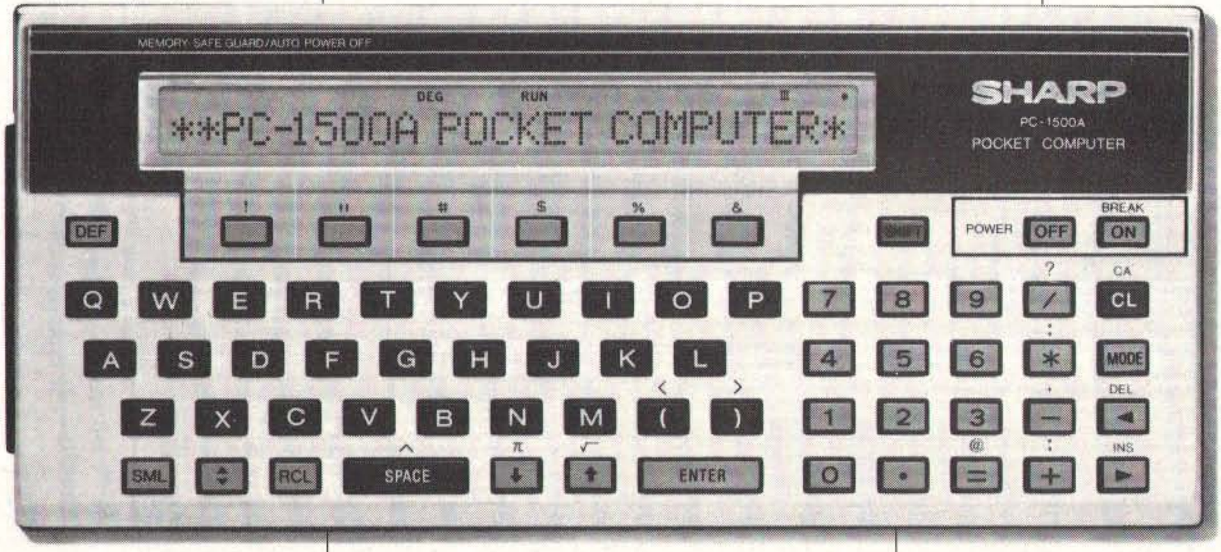

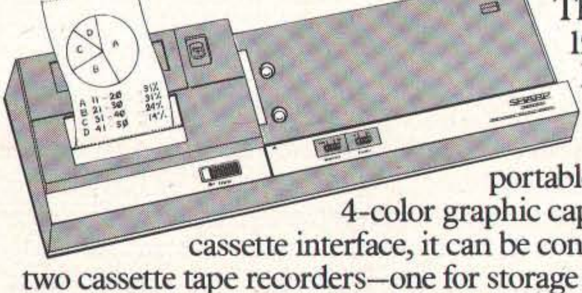

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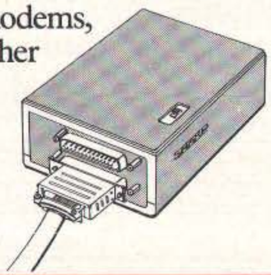

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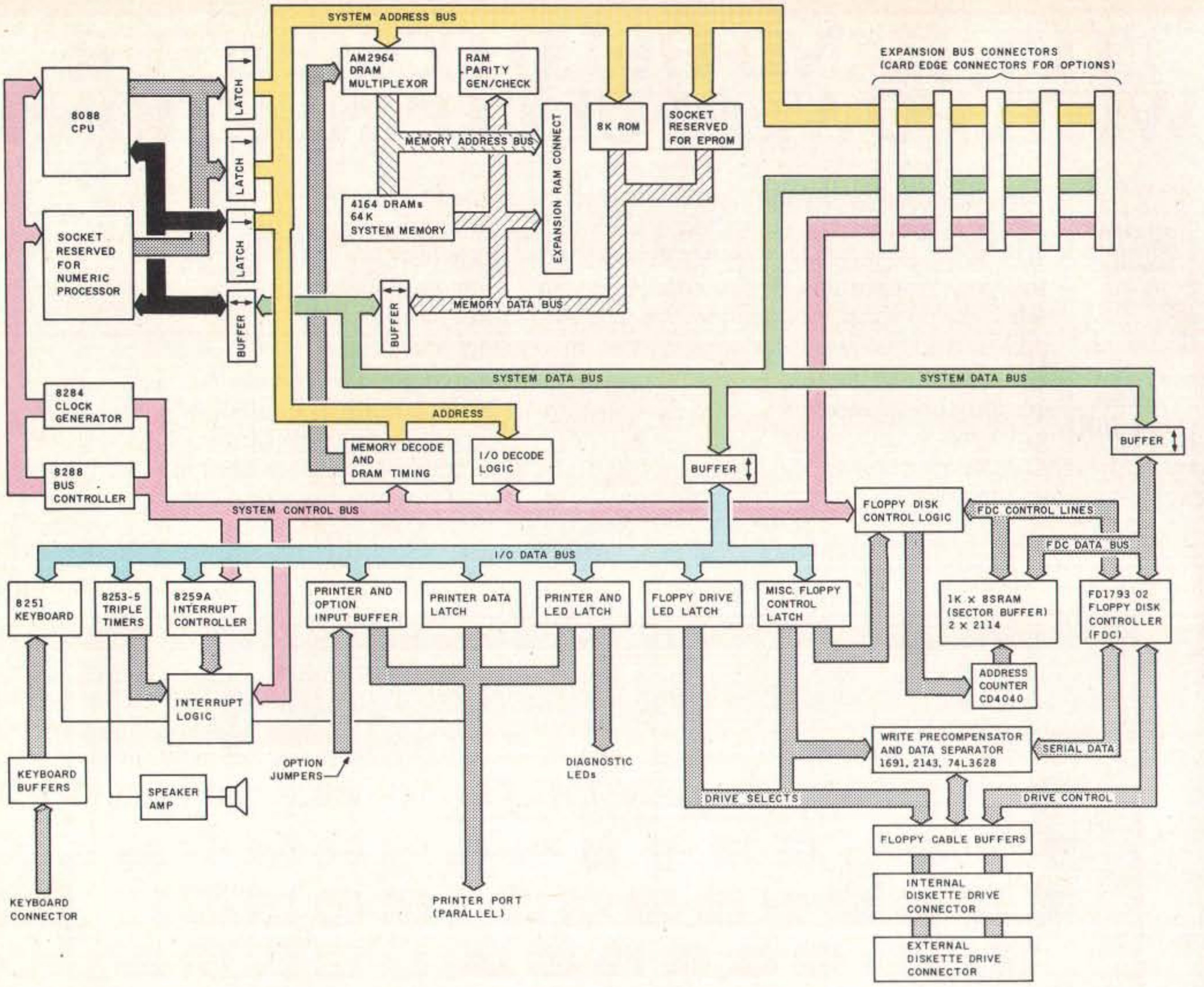

Figure 1: *The Professional Computer's system unit board contains circuitry for controlling up to four floppy-disk drives, a parallel printer port, five expansion slots, sockets for an 8087 numeric coprocessor, and an additional 8K bytes of ROM. An additional expansion slot is provided for memory expansion.*

Western Digital chip set comprising the FD1793-02 controller, WD1691 support logic, and WD2143 pulse delay. One surprise was the provision for 80-track drives (96 tracks per inch). Merely changing one jumper on the system board makes the system support 640K-byte drives. All the disk primitives for reading and writing sectors, locating, reading, or modifying the disk parameter tables, and turning motors on and off are contained in the system ROM, including support for the 80-track drives. The software in the system ROM reads the system configuration from the jumper and then calls the appropriate built-in routines. An undocumented option in the operating-system configuration program, CONFIG.COM, tells MS-DOS about these high-capacity drives; entering the command CONFIG *d:*=2,80 at the MS-DOS prompt, in which *d:* is the drive letter, will do it.

A second surprise was an additional connector for two external drives. TI recommends running a cable from the 40-pin connector on the system board to a 37-pin D-type connector on the back panel (see photo 3), but by using half-height drives, you can mount all four in the system unit. The power supply can handle it. And you can mix any combination of single-/double-sided, double-/quad-density drives if at least one (drive A) is an "MS-DOS standard" double-sided, double-density, 320K-byte drive.

The efficient, switching-type power supply is rated at 160 watts with three output voltage levels. TI claims this supply can handle a system with any combination of options, including two floppy disks and a Winchester disk or four floppy disks.

The Keyboard

The keyboard on the Professional Computer is one of the machine's nicest features; unlike the IBM keyboard,

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Vector	Description		
00	divide-by-zero trap		
01	single-step trap		
02*	non-maskable interrupt		
03	break (single-byte) software interrupt		
04	overflow trap		
05–1F	reserved by Intel		
20–3F	reserved by Microsoft for MS-DOS		
40	8259 interrupt 0		
41	8259 interrupt 1		
42	8259 interrupt 2		
43*	8259 interrupt 3 (timer 1)		
44	8259 interrupt 4		
45	8259 interrupt 5		
46*	8259 interrupt 6 (disk controller)		
47*	8259 interrupt 7 (keyboard USART)		
48*	speaker DSR interface		
49*	CRT DSR interface		
4A*	keyboard DSR interface		
4B*	parallel port DSR interface		
4C	clock and analog interface board		
4D*	disk DSR interface		
4E*	time-of-day clock DSR interface		
4F*	system configuration call		
50*	fatal software error trap **		
51*	restart timing event **		
52*	cancel timing event **		
53*	SVC interface subroutine **		
54*	activate task subroutine **		
55–56	reserved for future use **		
57*	CRT mapping vector		
58*	system timing, 25 ms (time slicing)		
59*	common interrupt exit vector (ROM)		
5A*	system timing, 100 ms (timing service)		
5B*	keyboard mapping vector		
5C*	keyboard program pause key vector		
5D*	keyboard program break key vector		
5E*	keyboard print screen vector		
5F*	keyboard queueing vector		
60	system ROM	DS pointer	(180H)
	(F400:A000)	DS size	(182H)
61	factory ROM	DS pointer	(184H)
	(F400:0000)	DS size	(186H)
62	option ROM	DS pointer	(188H)
	(F400:2000)	DS size	(18AH)
63	option ROM	DS pointer	(18CH)
	(F400:4000)	DS size	(18EH)
64	option ROM	DS pointer	(190H)
	(F400:6000)	DS size	(192H)
65	option ROM	DS pointer	(194H)
	(F400:8000)	DS size	(196H)
66	memory size (in paragraphs)		
	outstanding interrupt count (in paragraphs)		
	installed drive types (byte)		
67	extra system configuration (config. word 1)		
	extra system configuration* (config. word 2)		
E0–E3	reserved by Digital Research for CP/M		

* Vector actually used by ROM
** Texas Instruments use only

Table 1: *Hardware and software interrupts play an important role in the operation of the Professional Computer. The interrupt vectors listed here can be changed by system and application programs to provide a variety of custom functions, including keyboard redesign.*

it uses a familiar, efficient layout. This keyboard remains quiet while still providing the necessary tactile feedback.

The main keyboard uses the familiar Selectric-style layout, as shown in figure 2. The left-hand Shift key is where most people expect to find it, and a handy red LED (light-emitting diode) on the Caps Lock key reminds you when it's in use. The Control key's position provides easy use with word processors like Wordstar, and the ubiquitous Alt key sits directly under it, enabling a two-fingered system reset (by simultaneously pressing the Control, Alt, and Delete keys). Indentations on the F and J keys let you find the proper position on the home row easily.

Unlike the IBM keyboard, TI's uses a familiar efficient layout that's quiet, too.

A diamond-pattern cursor pad, with a Home key in the middle, sits to the right of the main keyboard. Although a T-configuration may work better, a diamond pattern beats a straight line any day.

To the right of the cursor diamond sits a numeric keypad. The little bump on the 5 key is for homing purposes; the keypad also contains comma, tab, and space keys.

Above the main keyboard, a row of 12 programmable function keys is arranged in three groups of four keys each. These keys send different codes in combination with the Shift, Control, and Alt keys for a total of 48 codes. The debate over the usefulness of function keys continues; if you like function keys, this will be heaven. These keys are easily accessible from BASIC with the KEY command. Unfortunately, the 25th display line only shows 10 key labels at a time. If you want to use these keys from outside of BASIC, you must provide a machine-language routine as discussed in the last paragraph of this section.

Text continued on page 298

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Dynamic RAM:	
00000–0FFFF	64K-byte motherboard RAM
10000– FFFF	64K-byte expansion RAM board bank 1
20000–2FFFF	64K-byte expansion RAM board bank 2
30000–3FFFF	64K-byte expansion RAM board bank 3
40000–BFFFF	expansion bus memory
CRT controller:	
C0000–C7FFF	graphics RAM bank A
C8000–CFFFF	graphics RAM bank B
D0000–D7FFF	graphics RAM bank C
D8000–DDFFF	reserved
DE000–DE7FF	active character memory
DE800–DEFFF	phantom character memory
DF000	Bit 0—miscellaneous input buffer, BLUE feedback, read only Bit 1—miscellaneous input buffer, RED feedback, read only Bit 2—miscellaneous input buffer, GREEN feedback, read only Bit 3—miscellaneous input buffer, interrupt pending, read only
DF001–DF00F	miscellaneous input buffer
DF010–DF01F	graphics RED palette latch, write only
DF020–DF02F	graphics GRN palette latch, write only
DF030–DF03F	graphics BLU palette latch, write only
DF040–DF7FF	reserved
DF800–DF80F	attribute latch
DF810	CRT controller address register, write only
DF811	CRT controller status register, read only
DF812	CRT controller address register, write only
DF813	CRT controller address register, write only
DF814–DF81F	reserved
DF820	Bit 7—miscellaneous output latch, interrupt enable Bit 6—miscellaneous output latch, alphanumerics screen enable
Other peripherals:	
DF821–DFFFF	reserved
E0000–E7FFF	reserved for speech storage RAM
E8000–F3FFF	reserved
ROM usage:	
F4000–F5FFF	8K ROM space (clock/analog interface)
F6000–F7FFF	8K ROM space (local-area net option board)
F8000–F9FFF	8K ROM space (Winchester controller)
FA000–FBFFF	8K ROM space (reserved)
FC000–FDFFF	8K ROM space, 1 wait state (XU62)
FE000–FFFFF	8K system ROM, 1 wait state (U63)

Table 2: *The memory space of the system's 8088 microprocessor has been partitioned for use by the cathode-ray tube, graphics controllers, and other peripherals, and allowance has been made for the addition of "smart" peripherals by reserving ROM space.*

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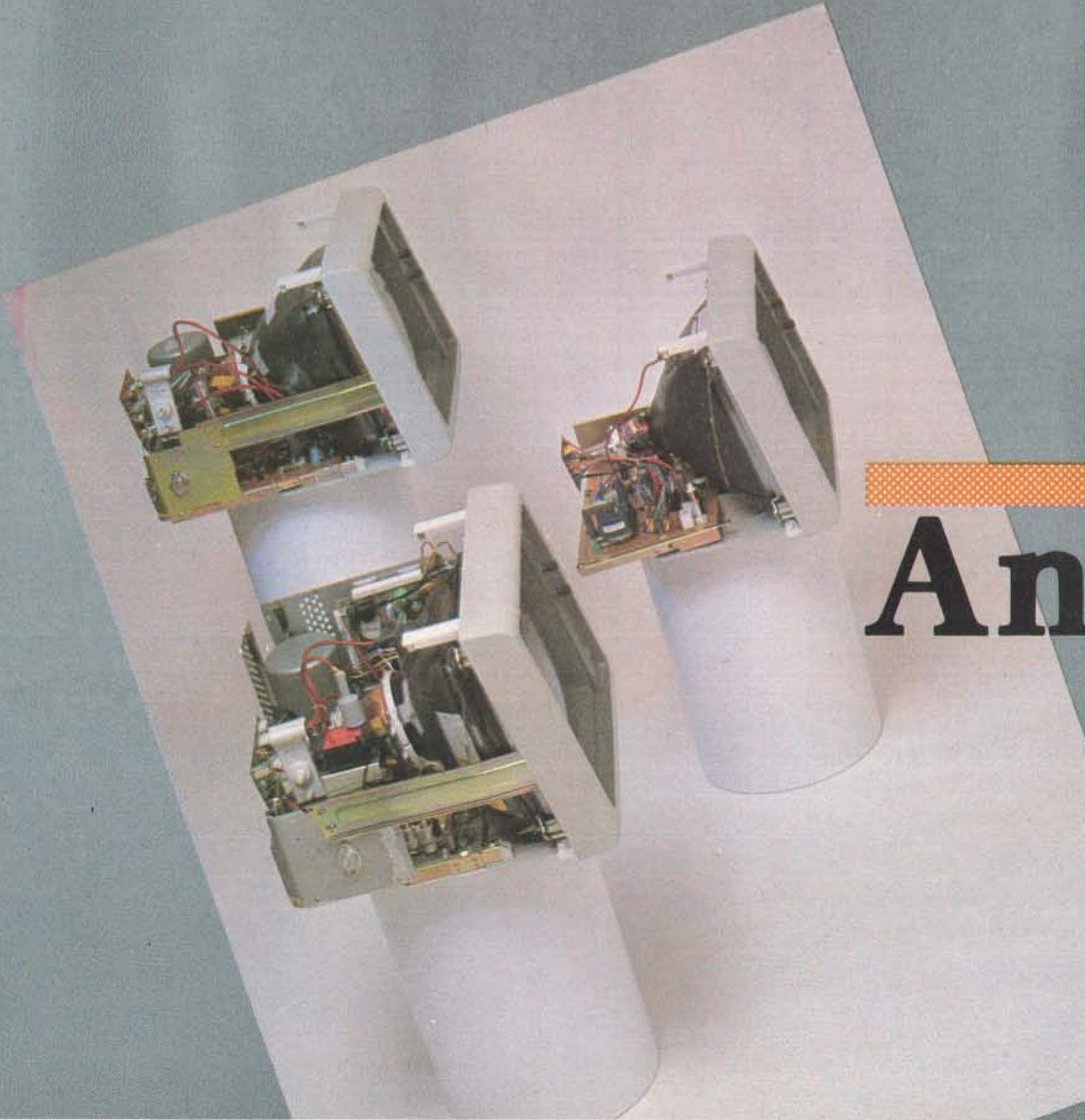

And a

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he HX-12 has the highest
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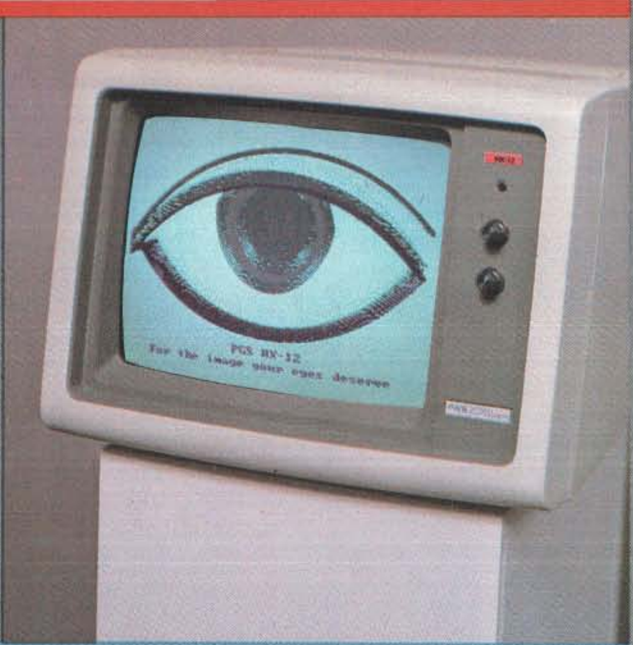

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orizontal resolution. However,
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truly of monochrome quality,
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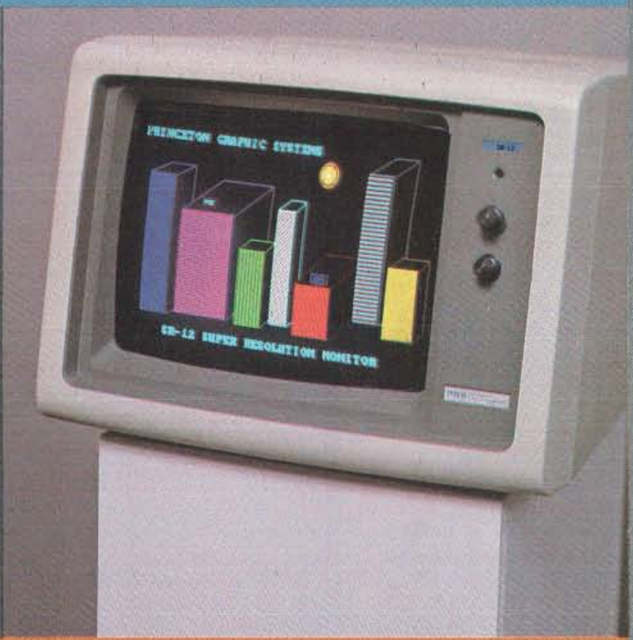

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Text continued from page 292:

Four keys, Insert, Delete, Break/Pause, and Print, are located above the numeric keypad. The Print key doesn't do anything on its own, but when used in conjunction with the Shift key, it generates a special interrupt that can be used by systems or applications software to send the contents of the display screen to the printer. The Insert and Delete keys do just that: insert or delete characters on the display. Normally, the unshifted Break/Pause key stops display scrolling and in BASIC causes a break to occur when shifted.

The keyboard's attractive, low-profile plastic enclosure (see photo 4) meets the European standard for the height of the home row, and the rows form a slight concave arc from top to bottom. The keyboard unit can be tilted by depressing two tabs at the upper corners of the keyboard housing, which causes a spring-loaded flap to drop from beneath the enclosure. The flap runs across the entire

Pin	Signal	Pin	Signal
A01	NMI	B01	Ground
A02	Data 7	B02	Reset
A03	Data 6	B03	+5 V
A04	Data 5	B04	IR0 (interrupt 0)
A05	Data 4	B05	no connection (bused)
A06	Data 3	B06	no connection (bused)
A07	Data 2	B07	−12 V
A08	Data 1	B08	DMA (CPU enable)
A09	Data 0	B09	+12 V
A10	Wait	B10	Ground
A11	Logic ground	B11	AMWC (memory write)
A12	Address 19 (MSB)	B12	MRDC (memory read)
A13	Address 18	B13	AIOWC (I/O write)
A14	Address 17	B14	IORC (I/O read)
A15	Address 16	B15	no connection (bused)
A16	Address 15	B16	no connection (bused)
A17	Address 14	B17	no connection (bused)
A18	Address 13	B18	no connection (bused)
A19	Address 12	B19	no connection (bused)
A20	Address 11	B20	PCLK (5-MHz clock)
A21	Address 10	B21	IR6 (interrupt 6)
A22	Address 9	B22	IR5 (interrupt 5)
A23	Address 8	B23	IR4 (interrupt 4)
A24	Address 7	B24	IR2 (interrupt 2)
A25	Address 6	B25	IR1 (interrupt 1)
A26	Address 5	B26	no connection (bused)
A27	Address 4	B27	RFSH (refreshing)
A28	Address 3	B28	ALE (address latch)
A29	Address 2	B29	+5 V
A30	Address 1	B30	OSC (15-MHz clock)
A31	Address 0 (LSB)	B31	Ground

Table 3: *Although many of the pins on the expansion bus connectors have the same function on both the TI Professional Computer and the IBM PC, the two buses are not compatible. The major differences occur in the control bus, including the signal lines for memory read and write, I/O read and write, and interrupt request lines.*

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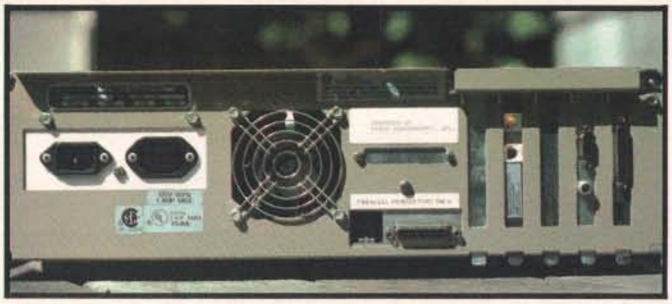

Photo 3: *The rear panel of the computer holds (from left to right) the power cord connectors for the system unit and display, the fan, the keyboard DIN plug connector, the parallel printer port connector, a cutout for a DB-37 connector for expansion disk drives, two modular phone jacks on the modem card, an RCA jack for composite video output for a monochrome display (just below the RGB outputs for a color display), and the DB-25 connector on the synchronous/asynchronous communications adapter card. The two screws in the upper left- and right-hand corners are all that need to be undone to remove the system unit cover. The design is remarkably similar to that of the IBM PC, right down to the metal flaps that cover the unused expansion-slot openings.*

width of the enclosure and lets the keyboard be elevated even when it's on your lap. The keyboard is attached to the system unit by a sturdy coiled cord that, when fully extended, can reach about 5 feet from the front of the system unit.

The keyboard unit contains an Intel 8048 controller that scans the keyboard and not only transmits character information to the system unit but also receives commands from it. The keyboard sends information over a serial communications link at approximately 2400 bits per second (bps) and receives commands at 300 bps.

Upon power-up or system reset, the system unit sends a command to the keyboard, telling it to perform a self-test. Depending on the results of this test, the keyboard responds with one of three codes: self-test OK, ROM error, or RAM error. The system unit can also tell the keyboard to turn the repeat function on and off, lock and unlock the keyboard, and return a version number. The provision for turning a key click on and off is not supported and requires a hardware modification.

When you press a key, the keyboard transmits the code to an 8251 USART (universal synchronous/asynchronous receiver/transmitter) on the system board, which, in turn, generates a hardware interrupt. Then, 1 or 2 bytes are placed into the 8088's AX register (the first byte is generated only when the Shift, Caps Lock, Alt, or Control key changes states). Several things then happen, depending on which key was pressed; essentially, software interrupts pass control through the vectors residing in low memory, and the key code usually winds up in a small (15-character) buffer.

One of the keyboard interrupts can have a special purpose. Right after a key code is received from the keyboard, a keyboard-mapping interrupt is generated (INT 5B). Normally, the interrupt vector (located at 5B × 4 = 16C) points to an IRET instruction, essentially accomplishing nothing. But by changing the interrupt vector, you can give control to a custom routine to remap all or part of the keyboard or to filter out certain key codes. This technique can also be used to program the function keys.

The Display

When you turn on the TI Professional Computer, the quality of the display becomes immediately obvious. The characters exhibit sharpness not found on other computers (with the exception, perhaps, of the Victor 9000). Like that of the IBM PC, the Professional Computer's display system consists of two units: a controller board located in the system unit, and a CRT monitor. Unlike the IBM, however, TI's controller board can drive both an analog monochrome display and a TTL (transistor-transistor logic) color display (red-green-blue input). With a monochrome display, the "colors" are interpreted as eight levels of gray. With a color display, each character can be displayed in one of eight colors. An optional raster-graphics board can mount onto the CRT controller board piggyback style, thus preserving precious expan-

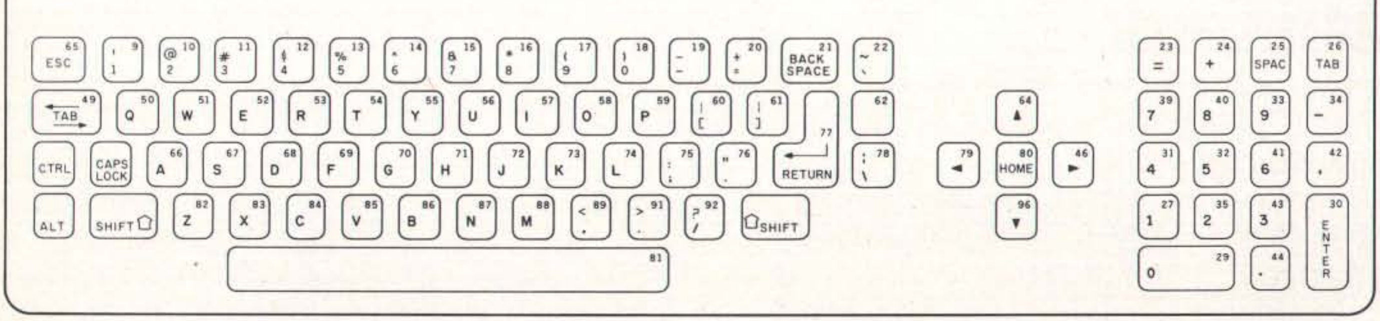

Figure 2: *The keyboard layout of the TI Professional Computer reveals a more conventional approach to keyboard design: separate alphabetic, numeric, and cursor keypads, and 12 programmable function keys grouped at the top. The numbers in the upper right-hand corner of each key are the scan codes that are transmitted to the system unit for further processing.*

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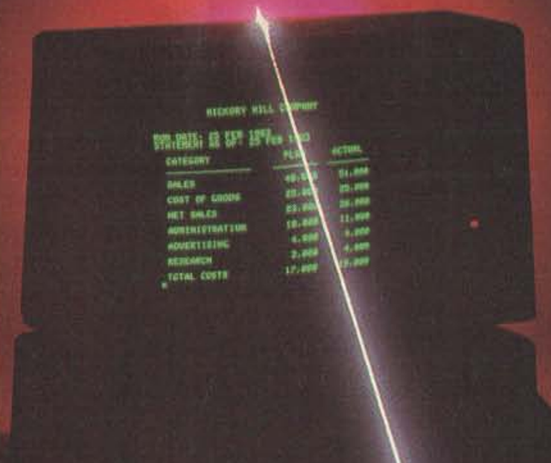

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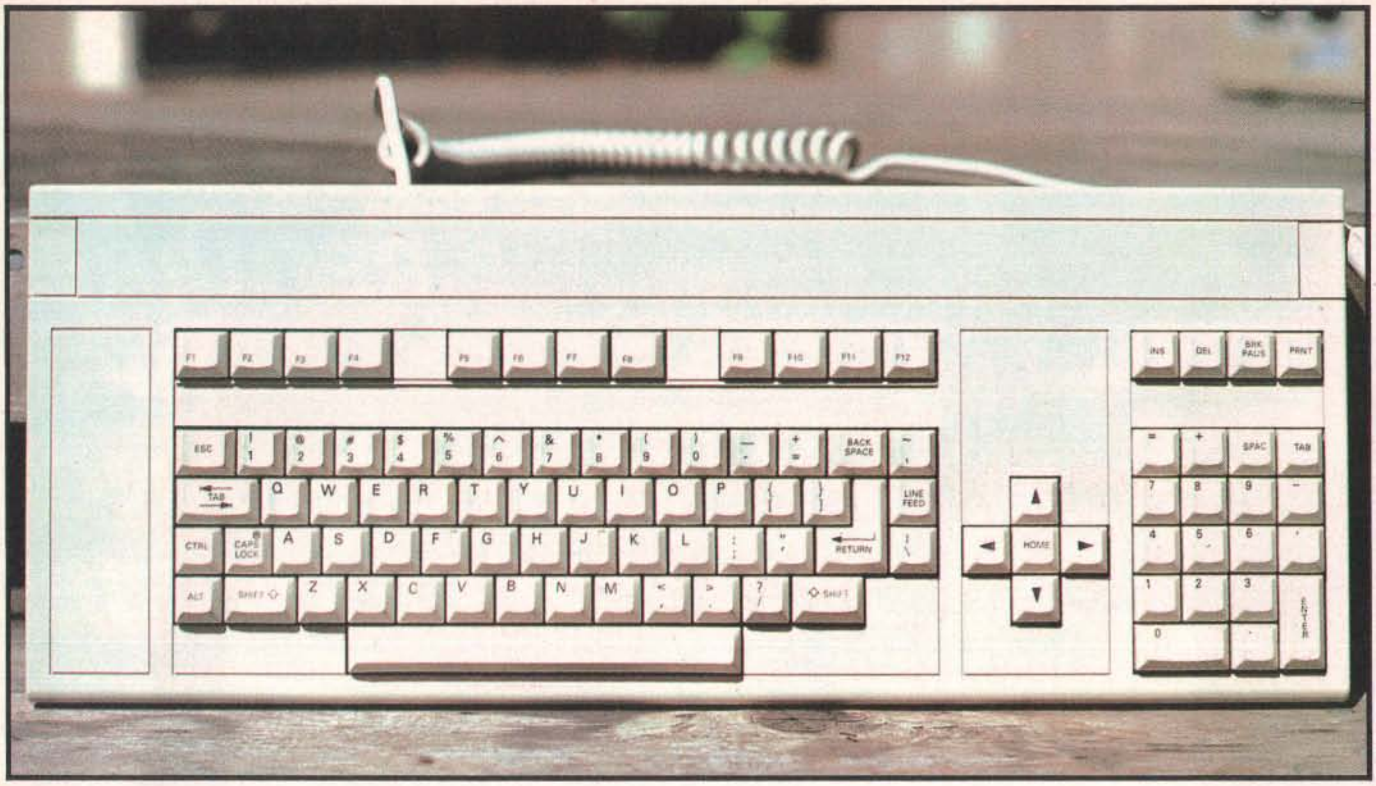

Photo 4: *The low-profile keyboard unit has a more familiar layout than IBM's. Indentations on the J and F keys help you find the home row. The tabs on each side of the unit near the top control a flap on the back that elevates the keyboard.*

sion slots. In addition, you can mix any combination of text and graphics on the display.

The basic CRT controller displays characters with a 7- by 9-dot matrix in a 9- by 12-dot cell. Twenty-five lines of 80 characters are displayed, thus requiring a resolution of 720 pixels horizontally (9 by 80) and 300 pixels vertically (12 by 25), which this system produces with excellent clarity, even on a color display. A full screen of text is shown in photo 5, and photo 6 is a close-up of the character formation.

Each character of the display uses 2 bytes of memory. The first byte is the actual character code. The second byte contains attribute information as follows:

Bit 0—Intensity level 1 (blue)
Bit 1—Intensity level 2 (red)
Bit 2—Intensity level 3 (green)
Bit 3—Character enable
Bit 4—Reverse
Bit 5—Underscore
Bit 6—Blink
Bit 7—Alternate character set

As mentioned earlier, the three intensity levels produce eight colors or levels of gray.

System software enters attributes for each character through an *attribute latch*. All characters to be displayed thereafter will then exhibit those attributes until new attribute values are entered. Characters can be read from the screen, too, and when this occurs the character's attribute is loaded into the attribute latch, facilitating block moves of characters and their attributes.

The attributes have a hierarchical order to resolve possible conflicts. Color attributes have the highest priority, followed by reverse video, character enable, blink, and lastly, underscore. For example, when you disable a character, its color attributes remain while blink and underscore are ignored. The result is an entire cell displayed in the color attribute(s) without visible blinking or underscore.

Although you get scrolling in four directions, it requires a fair amount of software support. Because the display "wraps," the software must clear either the top or bottom line of the screen before scrolling up or down, respectively. If a 25th "status" line is implemented, software must keep it in its place; otherwise it, too, would scroll with the rest of the screen.

The controller logic lets the 8088 have good access to screen memory. The screen memory's refresh logic enables two complete memory cycles to occur between character display refreshes. One fetches the character for display, and the other is then available to the 8088 for reading or writing. There is some slight synchronization overhead that brings the actual time to no more than 1 microsecond; the usual access time is 600 nanoseconds.

The characters themselves are produced by a 4K-byte character generator ROM in a fairly standard way, with row data loading into a shift register and dots shifted out at the dot rate. In effect, characters are painted across the screen, one row of dots at a time. The ROM contains 256 characters, but provision has been made for switching in an additional character ROM or EPROM

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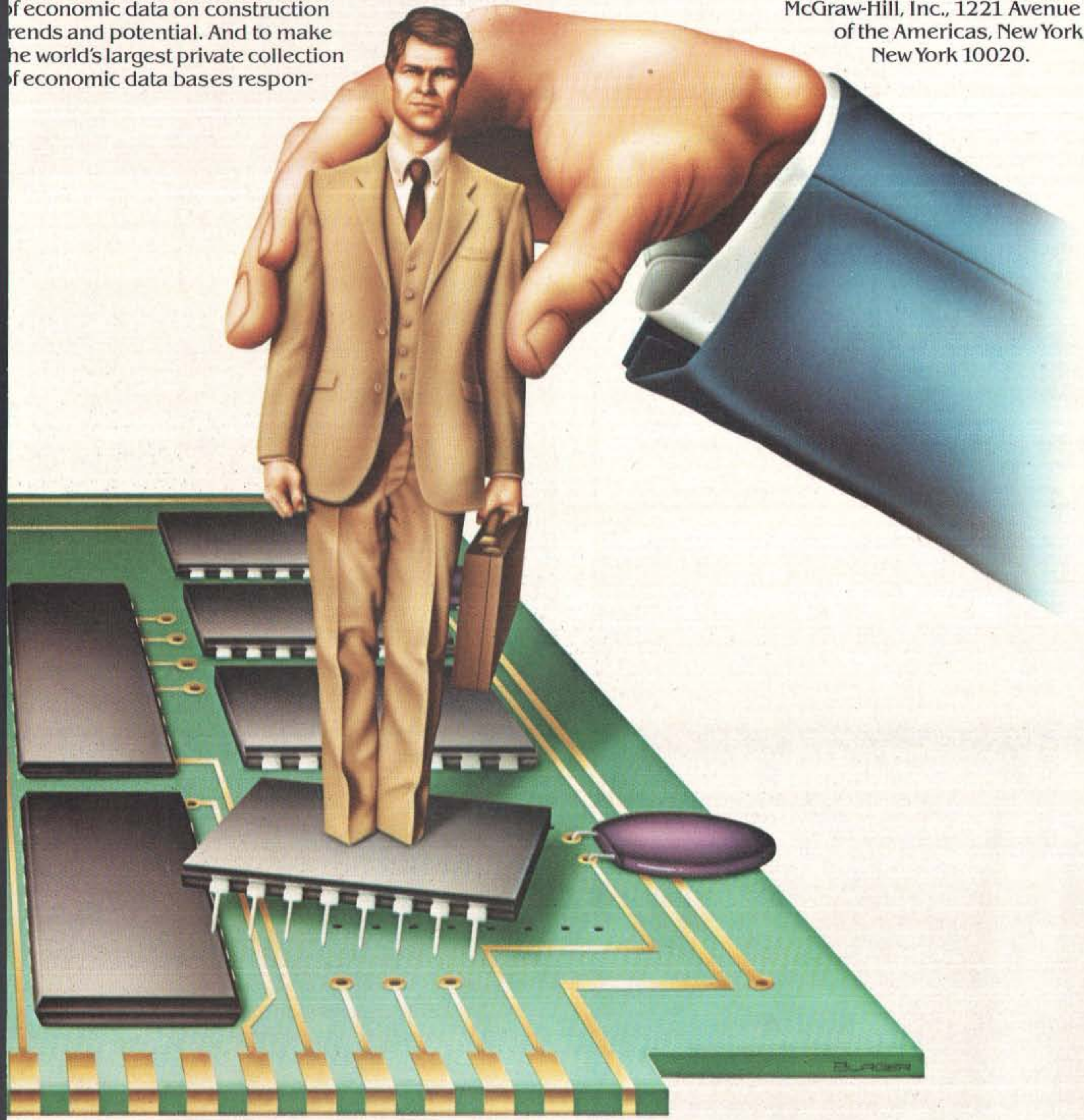

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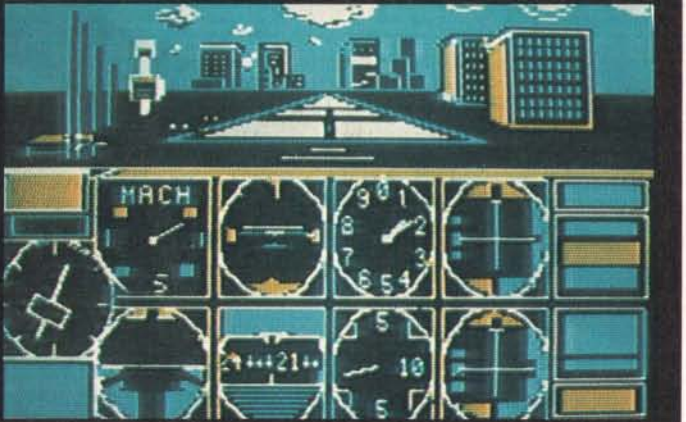

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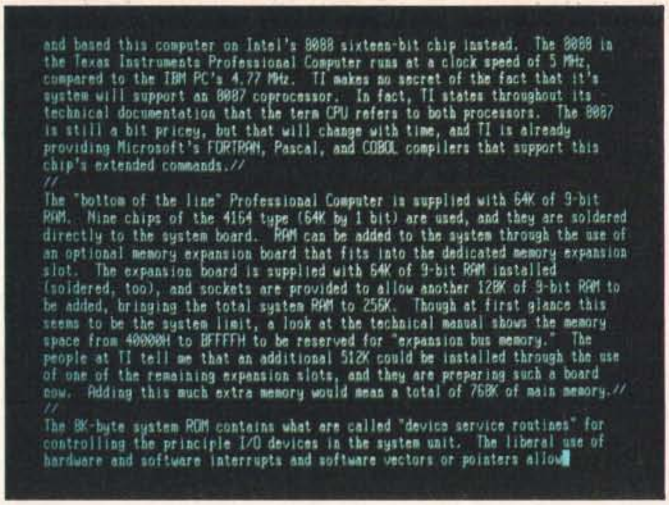

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and based this computer on Intel's 8088 sixteen-bit chip instead.  The 8088 in
the Texas Instruments Professional Computer runs at a clock speed of 5 MHz,
compared to the IBM PC's 4.77 MHz.  TI makes no secret of the fact that it's
system will support an 8087 coprocessor.  In fact, TI states throughout its
technical documentation that the term CPU refers to both processors.  The 8087
is still a bit pricey, but that will change with time, and TI is already
providing Microsoft's FORTRAN, Pascal, and COBOL compilers that support this
chip's extended commands.//
//
The "bottom of the line" Professional Computer is supplied with 64K of 9-bit
RAM.  Nine chips of the 4164 type (64K by 1 bit) are used, and they are soldered
directly to the system board.  RAM can be added to the system through the use of
an optional memory expansion board that fits into the dedicated memory expansion
slot.  The expansion board is supplied with 64K of 9-bit RAM installed
(soldered, too), and sockets are provided to allow another 128K of 9-bit RAM to
be added, bringing the total system RAM to 256K.  Though at first glance this
seems to be the system limit, a look at the technical manual shows the memory
space from 40000H to BFFFFH to be reserved for "expansion bus memory."  The
people at TI tell me that an additional 512K could be installed through the use
of one of the remaining expansion slots, and they are preparing such a board
now.  Adding this much extra memory would mean a total of 768K of main memory.//
//
The 8K-byte system ROM contains what are called "device service routines" for
controlling the principle I/O devices in the system unit.  The liberal use of
hardware and software interrupts and software vectors or pointers allow█
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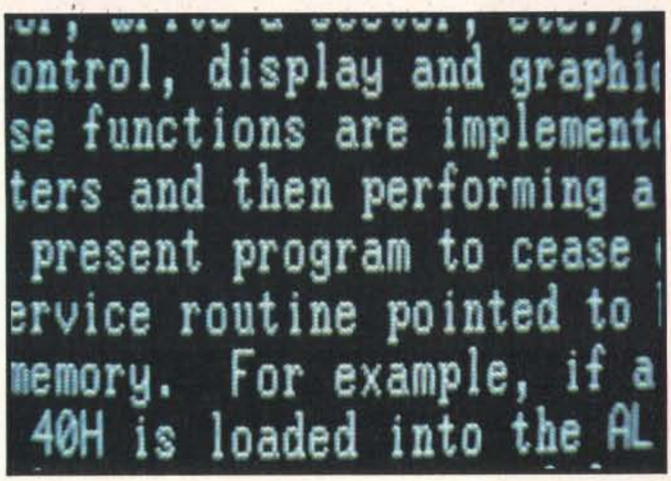
Photo 5: *The display on the Professional Computer is one of its most outstanding features. The resolution is 720 dots horizontally and 300 dots vertically. A user can mix text and graphics in any way.*



```
ontrol, display and graphi
se functions are implement
ters and then performing a
 present program to cease
ervice routine pointed to
memory.  For example, if a
 40H is loaded into the AL
```

Photo 6: *A close-up look at how the screen characters are formed.*

(erasable programmable ROM). Bit 7 of the attribute byte controls this switching, and the controller board includes a socket for the extra ROM. The addition of another character ROM makes it possible to display 512 characters.

The Professional Computer supports block, or character, graphics, but in an unusual way. In order to draw a solid horizontal line, there must be a way to fill the entire width of a character cell. But a character cell is 9 bits wide and the character generator can only put out 8 bits per character. This problem is solved in an interesting way. If the dots for any row of a character coming out of the character generator has bit 7 set, the leftmost and rightmost dots of that row are copied into the leftmost and rightmost dot positions of the character cell, thus enabling the entire character cell to be filled and consecutive characters to be contiguous.

As previously mentioned, the optional graphics board mounts directly onto the CRT controller board. It has the same resolution as the CRT controller board, 720 pixels horizontally and 300 pixels vertically. The graphics board is available in two configurations: one-plane (two colors: black and a choice of any one of eight colors) and

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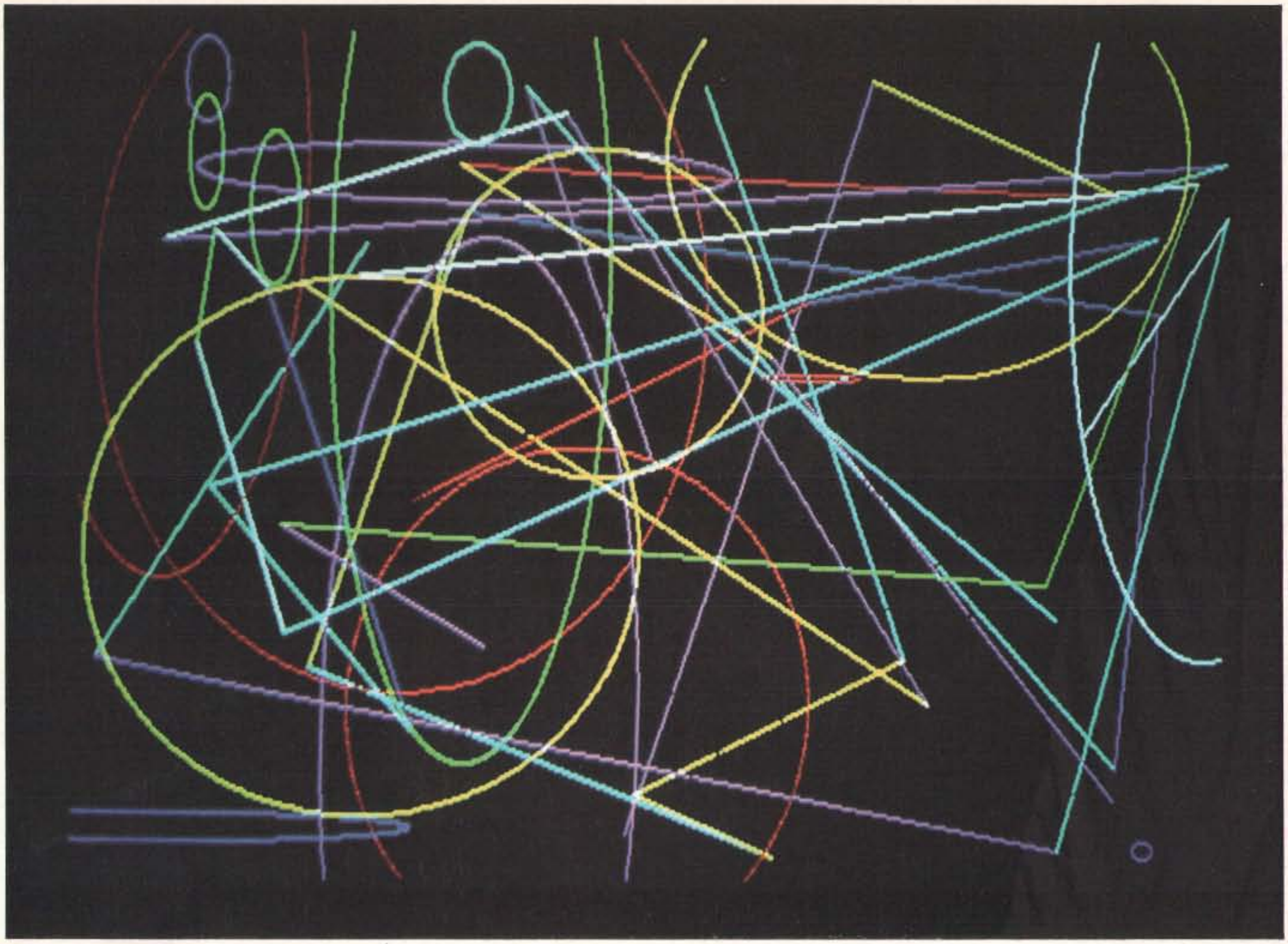

Photo 7: *An example of the graphics capabilities of the Professional Computer.*

three-plane (all eight colors). I had the eight-color option, in which each pixel is individually addressable and can contain up to three attribute bits that provide up to eight (2^3) colors. Some of the graphics capabilities are shown in photo 7.

Before you choose between the two- or eight-color graphics options, keep this in mind: the two-color version is not designed to be upgradable. If you think you'll want eight-color capability someday, get the three-plane board.

As implied above, the graphics boards contain color-mapping logic. The color information for each "palette" is held in one of three latches—one for red, green, and blue—on the graphics board. By changing the values in the palette latches, the code for cyan (101) could be converted to the code for, say, blue (001). Thus, all eight colors can be changed by loading new values into the palette latches.

Other Hardware Options

The synchronous-asynchronous communications board is capable of driving one RS-232C link in either asynchronous mode or one of several synchronous modes, including synchronous data-link control (SDLC) and high-level data-link control (HDLC). The heart of this board is, interestingly, a Zilog Z8530 serial communications controller chip. Most of the remaining circuitry on board handles the interface of this chip to the system bus. The on-board data-rate generator is software programmable and is capable of generating 17 rates from 50 to 19,200 bps. One DB-25 connector is mounted on the board edge facing the rear of the system unit.

If you purchase the optional Winchester-disk drive, you receive a 5- or 10-megabyte drive, a controller card, and the connecting cable. The drive may be manufactured by TI or Seagate. The version installed in the review unit was built by TI and had a 5-megabyte capacity (formatted). The 8088 views the controller as a block of four consecutive I/O ports. The controller generates interrupts when data is ready to be read from or written to the controller and when an operation is complete and the controller requests a status read. An on-board 4K-byte ROM contains the driver routines for the controller and can cause the controller to perform a self-test.

The internal 300/1200-bps modem supports auto-dialing and auto-answer as well as originate and answer modes. It can detect dial tones and busy signals and communicate asynchronously at 300 or 1200 bps; at 1200

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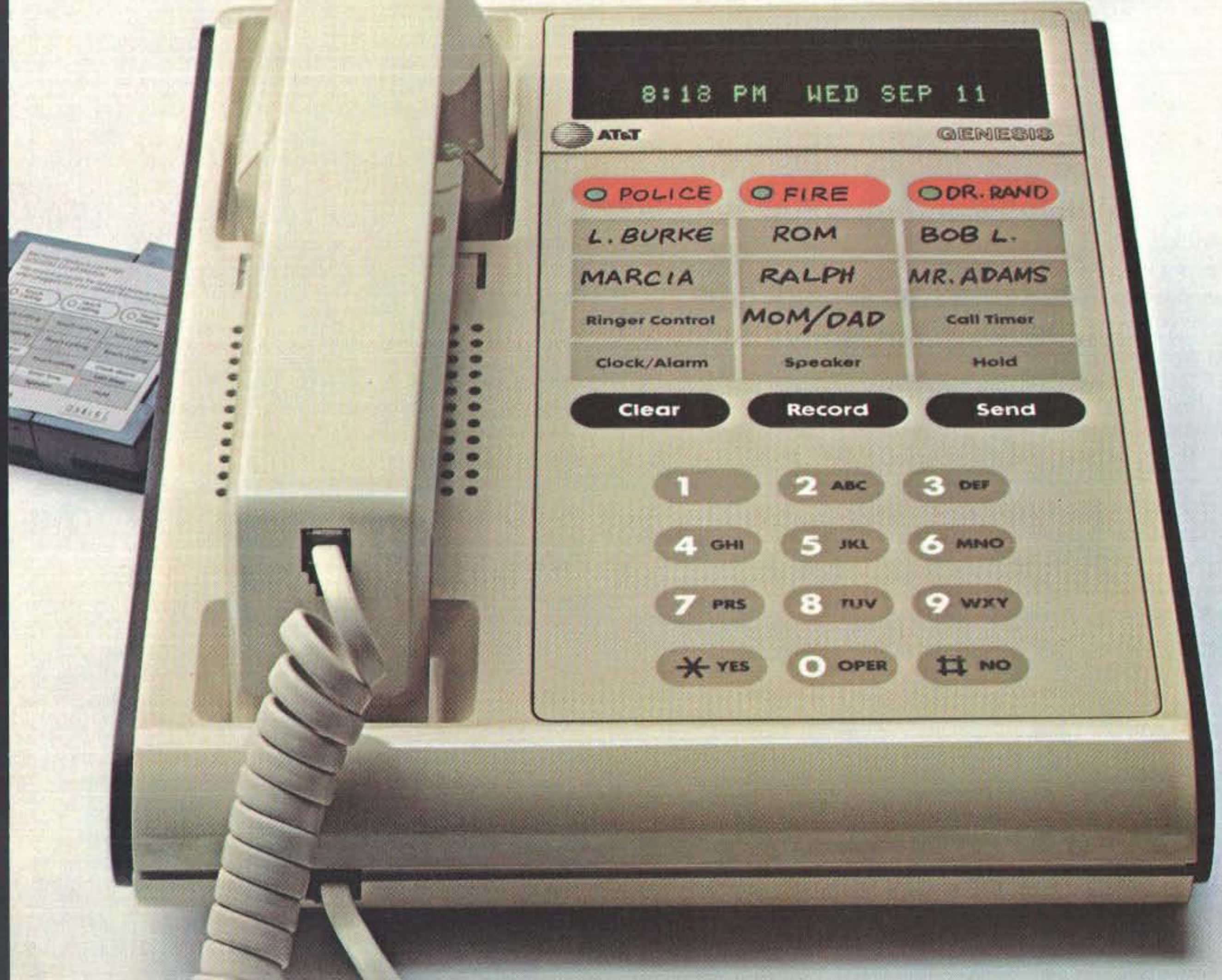

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bps, it can also communicate synchronously.

Software

The price of the basic Professional Computer doesn't buy any software—not even the operating system. MS-DOS cannot be called the standard operating system, but you can't help but notice that almost all TI-labeled software operates under MS-DOS.

I imagine most people buying this computer will buy the MS-DOS operating system. Currently TI only offers version 1.1 of this operating system, but version 2.0 should be available in December. Along with MS-DOS you get MS-BASIC, version 1.1. You can opt to purchase CP/M-86, which comes with CBASIC, but you'll pay more than twice as much. Concurrent CP/M is available, and the UCSD p-System is sold at three and a half times the cost of MS-DOS.

The MS-BASIC interpreter is similar to that supplied with the IBM PC (before its version 2.0) with the exception of some hardware-dependent commands and functions. I downloaded a fairly generic BASIC program from The Source that was originally intended for the IBM PC,

Text continued on page 314

TI's Improved BASIC

I actually tested two versions of BASIC, and therein lies a story. The first version I tested is the one currently being shipped, version 1.1. It contains several bugs.

The LOCATE command didn't always turn the cursor off. LOCATE ,,1 turns the cursor on and LOCATE ,,0 is supposed *to turn it off. If you've previously turned the cursor on (using another program or in the immediate mode) and then run a program that's supposed to turn the cursor off, it won't. If you run the program a second time, the cursor will go off. I tried using two LOCATE commands in a program, but even that didn't turn the cursor off the first run-through.*

As with IBM's BASIC, TI's BASIC version 1.1 contains a command to control a cassette-recorder's motor. It's the MOTOR command. The problem is, the TI computer doesn't support a cassette recorder. So what happens if you enter a MOTOR command? You may very well have to turn the computer off and on again to recover. It's not always that bad, but it's completely unpredictable.

The MOTOR command is not documented in the manual that comes with BASIC 1.1 except in one very obscure place. After the discussion of the KEY command, there's a brief description of what is called a "command super shift." This enables single-keystroke entry of 22 keywords by depressing the Alt key and one of the alphabetic keys. For instance, holding down the Alt key and at the same time pressing the I key produces the INPUT keyword. Pretty neat. But what in blazes is this information doing in the discussion of the KEY command? The MOTOR command, which is produced using the M key, is included in the list of keywords that each alphabetic key produces. So I pressed the Alt-M combination and, sure enough, up popped the word MOTOR on the screen. Hitting the Return key caused a complete system failure, and it was necessary to turn the machine off and then on again. Yes, even the Control-Alt-Delete combination didn't do anything.

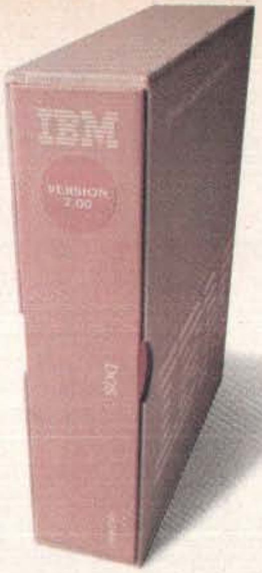
While I'm on the subject of documentation, let me say that the manual for BASIC 1.1 is terrible. Besides the screwy placement of the command super shift summary, there is absolutely no information on the various switches you can control when you first invoke BASIC. (For the benefit of those seeking this information, these switches include /M:, which sets the maximum workspace used by BASIC to provide room for assembly-language subroutines; /S:, which sets the buffer size for random-access files; /F:, which sets the maximum number of files that may be open at any one time; and /C:, which controls the size of the communications input buffer when using the synchronous/asynchronous card.) Oh yes, these switches exist. In fact, they are referred to in several places in the manual (except for /F:), always as part of the discussion of something else. But nowhere are you told what they are or how they work.

One feature not explained in the user documentation but found in the technical manual is the special use of the Alt key. By holding down the Alt key and entering the three-digit number on the numeric keypad, you can generate any character code, decimal 0 to 255. For example, by holding down the Alt key while entering 155 on the numeric keypad, the character code 155 (i.e., ¢) is generated (CHR$(155) in BASIC). It's a mystery to me why this is not included in the user documentation.

Then there is the case of the missing commands and statements. There are some very common commands and statements that are part of BASIC 1.1 but are not documented. For example, little things like the SYSTEM command to get you back to MS-DOS. Then there is the matter of the DATE$ and TIME$ statements (and variables). These work just fine if you know how to use them, but don't try to find them in the manual. Although the FILES command is in the documentation, you'd be hard pressed to find it. Here are some other undocumented commands: BEEP, COM(n), KEY(n), ON COM(n) GOSUB, ON KEY(n) GOSUB, ON PEN GOSUB, ON STRIG(n) GOSUB, STRIG, and STRIG(n). Lastly, the RESET command is in the index but nowhere else.

I think I've covered the really serious omissions. As far as I can tell, TI didn't put any extra effort into the BASIC 1.1 manual the way IBM did. IBM's is not that *good, but at least Big Blue tried to give some examples to clarify the more complicated commands, and the company has organized its manual better than TI has. It appears that TI simply copied the Microsoft documentation verbatim and left parts out.*

While discussing the preceding problems with the people at TI, I was informed that the company is about to release a new version of BASIC, version 1.2, that has fixed all these bugs and others that I hadn't uncovered, and that it comes with an improved manual that documents all the commands and features. TI packed up a copy of the new BASIC floppy disk and the final draft of the manual that afternoon and shipped them air express, through a hurricane, so I could review them before completing this article. I'm happy to report that, indeed, the previously mentioned bugs are gone. The MOTOR command is still there, but trying to execute it gives you a simple "Device Unavailable" message instead of a system failure. Also, the new manual will be beautiful; comparing it to the version 1.1 manual is like comparing night to day. Besides being complete, the manual has plenty of examples and illustrations to explain the more difficult commands. The material is organized in a more rational way, and it is evident that a lot of effort went into this revision. This manual will be better than IBM's.



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Benchmark	Professional Computer	IBM PC XT (DOS 2.0)
1A Loop	0:05.5	0:06.9
1B Division	0:16.9	0:24.7
1C Gosub	0:09.7	0:12.8
1D Strings	0:19.9	0:23.8
1E Prime sieve	2:38.2	3:12.0
1F Disk write		
single-sided		
loaded	0:29.8	0:29.0
unloaded	0:30.4	*
double-sided		
loaded	0:29.5	*
unloaded	0:29.9	*
Winchester	0:07.1	0:08.0
1G Disk read		
single-sided		
loaded	0:19.4	0:23.0
unloaded	0:20.0	*
double-sided		
loaded	0:19.3	*
unloaded	0:19.7	*
Winchester	0:05.1	0:08.0

*not tested

Table 4: *A comparison of the BYTE benchmarks (see listing 1 on page 316) run on the Professional Computer and the IBM PC XT. Both versions of TI's BASIC ran the tests in the same time.*

Text continued from page 310:

and it ran without modification on the TI. You'll encounter problems, however, if the program involves graphics or other hardware-dependent routines. The commands may look the same, but they don't always have the same range of parameters. See the text box on page 310 for software bugs and documentation deficiencies that have been repaired in version 1.2.

TI's BASIC contains some interesting enhancements. For example, when you first invoke IBM's BASIC, you are constrained by 128-byte random disk-file buffers and a maximum of three open files unless you specify switches /S: and /F:, respectively. TI's BASIC handles this dynamically, accepting file records of any size, and as many as 255 files open simultaneously without the need to specify this when invoking the language.

TI's version of MS-BASIC contains an editor similar to that in IBM's BASIC. Microsoft has produced one of the nicest BASIC editors I've seen. You don't even have to go into an edit mode to use it. For example, you've listed 10 lines of code you just wrote and notice that on one line you entered "THE" instead of "THEN." Just place the cursor after the *E* in "THE," tap the Insert key, type an *N*, and press Return. You've just corrected the line.

The editing features don't end there. Suppose, for instance, that you have to enter 15 lines of code, and each line is almost but not quite identical. (Let's say it's a series of LINE statements and only one variable is different in each line.) No problem. Simply enter the first line as you normally would. Then, to enter each succeeding line, you merely place the cursor on the first line you entered, change the old line number to the new line number, and then change the variable (from A to B, for example) and press Return. You won't see the original line of code anymore because you've written over it, but if you entered a LIST command, you'd see both lines. You can continue to do this for each succeeding line until you're finished. In essence, you can build the remaining 14 lines of code from the first line by entering only what is different from one line to the next. The process is quite a time-saver.

I ran the standard BYTE BASIC benchmarks for comparison with other machines and the results are outlined in table 4. Because the floppy-disk drive in the review machine used a head-load solenoid, I ran the disk write and read benchmarks (6 and 7) both with the head initially loaded and unloaded. As the results show, head-loading takes approximately 0.5 second. I also ran these benchmarks using both single- and double-sided disks. As I expected, the times for a single-sided disk are slightly longer due to the extra head seeks involved, whereas a double-sided disk allows two tracks, one on each side of the disk, to be written or read without the head assembly moving. The timings for benchmarks 6 and 7 using the Winchester-disk drive are included just for fun. As you can see, the times for the Winchester are about one-quarter of those for the floppy-disk drive. By the way, all the benchmark times for the two versions of TI's BASIC were exactly the same. The benchmarks used are shown in listing 1.

The graphics in TI's BASIC are somewhat simpler than in IBM's BASIC, primarily because the TI has only one mode. You always work with high-resolution graphics: 720 pixels horizontally, 300 vertically, and any pixel can be one of eight colors. No distinction exists between text and graphics modes; you can mix the two freely. You can plot individual points, lines, boxes (filled or outline), circles, and ellipses. A PAINT command fills any odd shape with a color, and GET and PUT commands move whole shapes around on the screen. The PALETTE and PALETTE USING commands enable rapid changing of all eight colors simultaneously. And a DRAW command, as on the IBM PC, uses its own macro language that enables it to perform the functions of most of the other graphics commands. The macro language lets you move any distance in eight directions, plot points and lines, and set color and scale. By combining several macro commands into a single string variable, a simple command like DRAW A$ can perform a complex series of movements. In addition, one command executes a substring, like a sort of subroutine, so that repeating patterns can be defined individually and then strung together by a series of commands that executes substrings.

Two commands control the speaker: SOUND and

Text continued on page 318

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Listing 1: *The standard BYTE benchmarks used in this review.*

```
LISTING 1A

60 A=2.71828
80 B=3.14159
100 FOR I=1 TO 5000
320 NEXT I

LISTING 1B

60 A=2.71828
80 B=3.14159
100 FOR I=1 TO 5000
120 C=A/B
320 NEXT I

LISTING 1C

60 A=2.71828
80 B=3.14159
100 FOR I=1 TO 5000
120 GOSUB 1000
320 NEXT I
340 END
1000 RETURN

LISTING 1D

80 A$="abcdefghijklm"
100 FOR I=1 TO 5000
120 B$=MID$(A$,6,6)
320 NEXT I

LISTING 1E

10 SIZE=7000
20 DIM FLAGS(7001)
30 PRINT"only 1 iteration"
40 COUNT=0
50 FOR I=1 TO SIZE
60 FLAGS(I)=1
70 NEXT I
80 FOR I=0 TO SIZE
90 IF FLAGS(I)=0 THEN 170
100 PRIME=I+I+3
110 K=I+PRIME
120 IF KSIZE THEN 160
130 FLAGS(K)=0
140 K=K+PRIME
150 GOTO 120
160 COUNT=COUNT+1
170 NEXT I
180 PRINT COUNT," primes"

LISTING 1F

10 CLEAR 1000
40 A$="12345678123456781234567812345678"
60 B$=A$+A$+A$+A$
80 NR=500
100 OPEN "R", #1, "TEST"
120 FIELD #1, 128 AS Z$
140 FOR I=1 TO NR
160 LSET Z$=B$
180 PUT #1, I
200 NEXT I
220 CLOSE #1
240 PRINT "DONE"
```

Listing 1 continued on page 318

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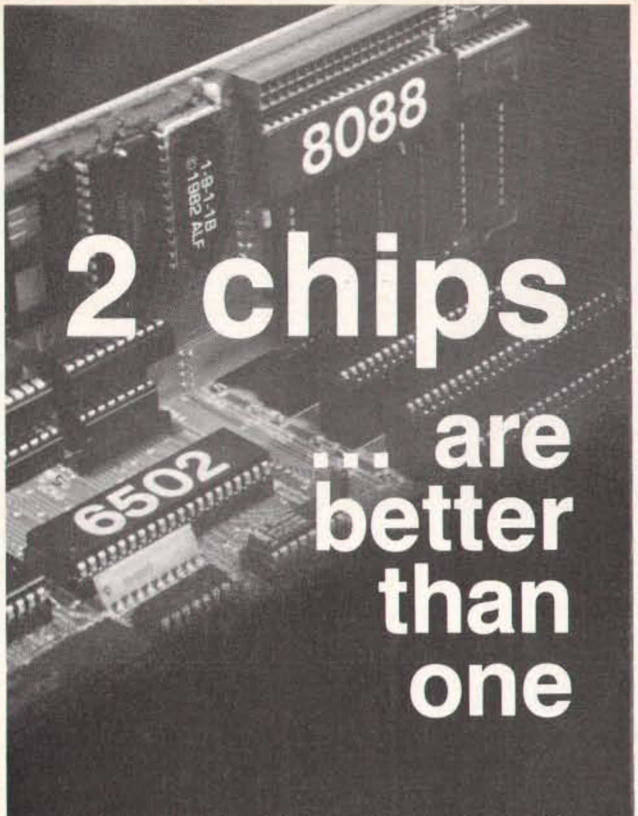

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Listing 1 continued:

```
LISTING 1G

10 CLEAR 1000
80 NR=500
100 OPEN "R", #1, "TEST"
120 FIELD #1, 128 AS Z$
140 FOR I=NR TO 1 STEP -1
160 GET #1, I
200 NEXT I
220 CLOSE #1
240 PRINT "DONE"
```

Text continued from page 314:

PLAY. SOUND takes a pitch and duration for its arguments and produces a single note. PLAY is to sound what DRAW is to graphics. With the PLAY command you can create a string of macro commands and then execute it. Notes can be normal (⅞ of the note time), staccato (¾ of the note time), or legato (the whole note time), so that one note blends into the next. Octave and tempo can be changed, and pauses can be inserted. As with the DRAW command, a macro command is provided that will execute a substring. Here the notion of a substring is more apropos, being analogous to a repeating musical phrase.

The PLAY command provides another interesting macro command. The notes produced by the other macro commands can play in either foreground or background mode. When notes play in foreground mode, program execution pauses until all notes have been played. In background mode, however, the contents of the PLAY command are placed in a buffer and the notes play while the rest of the program continues. This command also affects the SOUND command. With a command like SOUND 1000,10 in a program, all activity ceases until that long note stops if you are in foreground mode. But background mode lets the program continue while the note plays at the same time. Combining graphics with background-mode music produces some remarkable results. Alas, it's still impossible to reproduce that total effect in a magazine.

TI's BASIC versus IBM's

Compatibility always looms as an issue with BASIC, especially when you have two versions of the same BASIC. TI's BASIC was, in fact, adapted from IBM's. How compatible are the two BASICS? In a word, very.

The new BASIC 1.2 manual contains one section that points out the differences between TI's BASIC and IBM's (and, of course, how TI's is better). Using this information, it would not be too difficult a task to convert any IBM BASIC program to TI BASIC and vice versa.

The major differences occur in commands affecting the display; differences in the hardware of the two machines become evident after looking at the commands. The IBM PC has a text mode and two graphics modes (medium and high), and the TI Professional Computer has a mixed text and high-resolution graphics mode only. And so TI's BASIC has no need for the SCREEN statement (the SCREEN command is the same). The structure of the COLOR command differs for the same reason; the

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TI has only one mode and only eight colors. The IBM and the TI PSET and PRESET statements are identical except that the higher resolution on the TI requires the parameter range to differ. TI BASIC also has a PSET STEP variation that defines the coordinates as an offset from the previous PSET statement instead of in absolute terms. TI's CLS (clear screen) function allows you to clear text only, graphics only, or both. IBM's and TI's POINT, LINE, CIRCLE, GET, PUT, PAINT, and DRAW functions are all identical except, again, for the parameter ranges. TI's BASIC also includes PALETTE and PALETTE USING statements but not the STICK function.

TI's BASIC version 1.2 and the new manual should be available by the time you read this article.

Communications

Along with the internal 300/1200-bps modem, the review unit came with a software package called TTY Communications. This sophisticated package features programmable function keys, lets you send and receive data at speeds up to 9600 bps manually or remotely, attended or unattended, and provides automatic dialing and answering of the modem. The package works with the internal modem, an external modem connected to the synchronous/asynchronous board, or a direct computer-to-computer link through the synchronous/asynchronous board. I found it fairly easy to use once I got past the documentation.

You begin by setting up the communications parameters for a particular communications link. These parameters are stored in a file to be called in as needed. Usually, you maintain a separate parameter file for each type of communications link. For instance, I created one parameter file for calls to The Source, another for remote sending and receiving of files from my office computer, and another that enabled me to automatically upload this text from the Model 100 into the Professional Computer.

The first of five parameter menus lets you set the port assignment, data rate, stop bits, parity, tone or pulse dialing, automatic or manual dialing, and a phone number.

The second menu enables you to define an *answerback message* (ABM). An answerback message is a string of characters sent to a remote computer to help identify who you are. You can designate that this message (if any) be sent either when answering a call or originating a call or both. You can even secure the ABM so that it won't be displayed on the local console.

Next, you can define what the TI computer will send as a *new-line* character (or characters) and what it will interpret as a new-line character in the incoming data stream. This can get confusing until you realize that, internally, the Professional Computer uses a carriage return/linefeed pair as a new-line sequence. If you define the incoming new-line sequence as a carriage return/linefeed, you'll wind up with double-spaced text on screen because the TI computer executes the incoming new-line sequence before its own. Instead, you need to define the incoming new-line sequence as only a carriage return and filter out all incoming linefeeds. It took me a while to figure out why everything was double-spaced when connected to The Source.

You can specify whether the computer responds to remote commands and performs handshaking, such as XON/XOFF. And you can disable the keyboard so that a cat's march across the unattended keyboard will not have serious effects. Finally, for this menu at least, you can designate two batch files: one is executed upon a normal disconnect, the other is executed upon an abnormal disconnect.

The third menu lets you define the method of handshaking (XON/XOFF, reverse channel, or none), a maximum inactivity time before hanging up, an error limit, the method of disconnection (an EOT (end of transmission) character or an EOT-DLE (data-link enable) character pair), and whether transmitted data, received data, or both should be displayed on the local console.

The fourth menu defines the 12 programmable function keys. Each key may contain up to 32 characters, including control characters. A carriage return, for example, is depicted as <CR> and counts as four characters.

The fifth and final menu enables automatic replacement of any character transmitted or received with another character or no character. Only single characters can be searched for and only a single character can be used as a replacement. This is the menu I used to filter out the code for linefeeds (i.e., replace them with nothing).

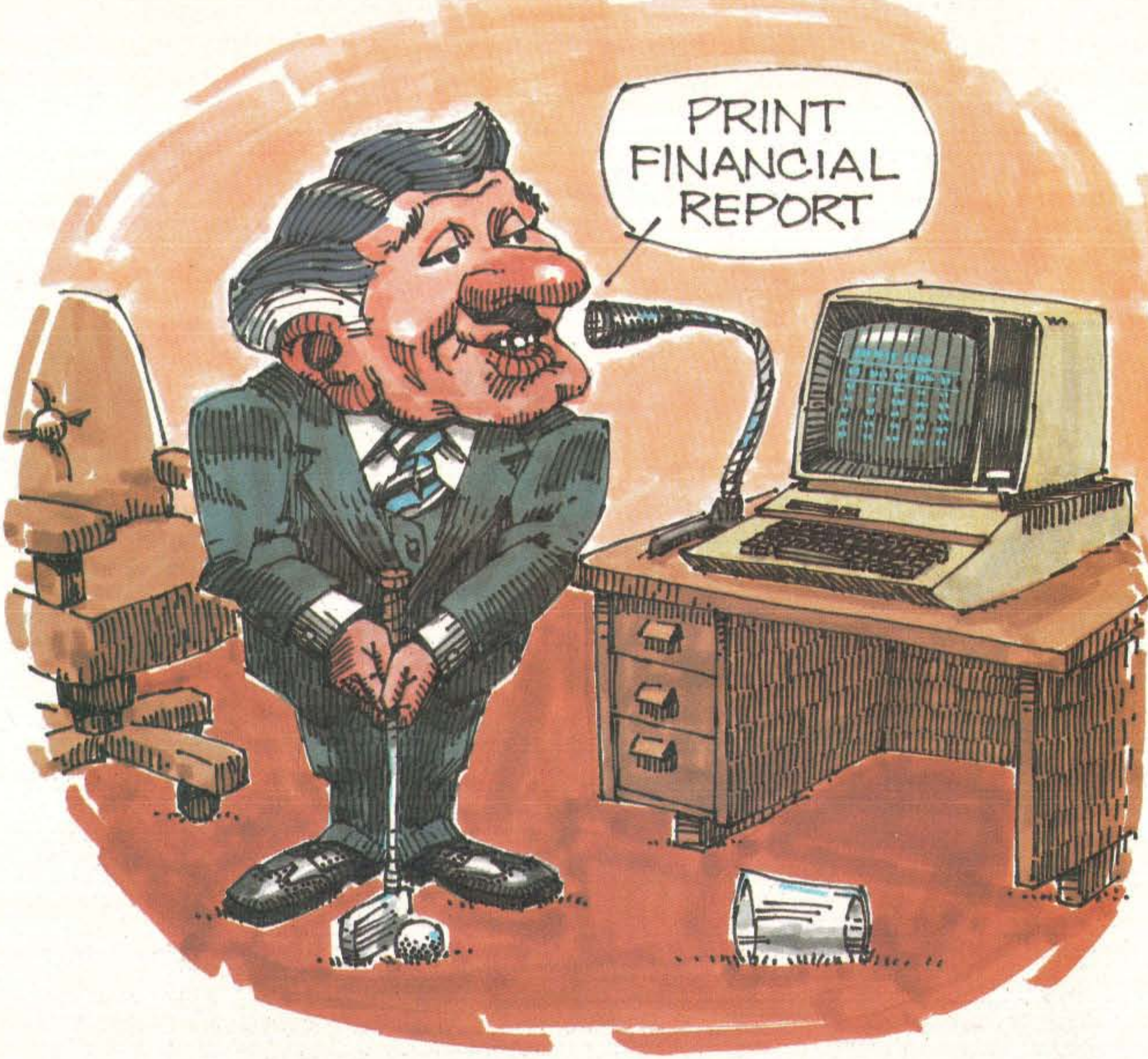
All of the menus are extremely easy to use. Good use has been made of color and highlighting, and most parameters can be changed by using only the cursor keys. Once you understand the parameters, it shouldn't take more than a couple of minutes to configure a new parameter file. Table 5 summarizes all the parameters, their range of values, and their default values.

After the parameters have been established, the operation of the program is straightforward. When I want to call The Source, I enter the command COMTTY SOURCE.PRM from the MS-DOS prompt. This loads the communications software and the parameter file, which then waits for a dial tone, dials the phone according to the number in the file, waits for a carrier, connects, and drops me into terminal mode. While this is going on, the program keeps me informed of its activities on a status screen that disappears as soon as a valid carrier is detected. I can then log in and enter my password by pressing Shift-F1, Shift-F2, as these two function keys were programmed into the parameter file.

Auto-dialing can be used with both TI's own internal modem and with the Hayes Smartmodem.

While in terminal mode, a key label line displays your options. Function keys control everything in this program, and in this case I must admit that they make life easy. In terminal mode you can also perform a number of file-related activities. Of course, you can upload and download files and view the directory (interestingly, this command asks "which directory?"), view the contents of files, rename files, delete files, print files, and create an empty file. At every point along the way, pressing

Look, Ma, no hands!



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Parameters	Range	Default
Port	1,2,3	1
Speed	110, 300, 1200, 2400, 4800, 9600, auto	300
Stop bits	1,2	1
Parity	odd, even, mark, space, None	even
Check parity	on, off	off
Display of transmitted data	on, off	off
Display of received data	on, off	on
Busy handling	DC1–DC3*, reverse channel, None	None
Busy sense	0,1	0
ABM**	0–32 character string	none
Call answer ABM	on, off	off
Call origination ABM	on, off	off
Secured ABM	on, off	off
Keyboard	on, off	on
Dialing mode	pulse, tone	tone
Dialing procedure	manual, automatic	automatic
Error limit	0–999 errors	0
Programmable keys	0–32 character string	none
Mapped characters	characters mapped	none
Transmit new line	0–10 character string	return, linefeed
Receive new line	0–2 character string	return, linefeed
Phone number	0–32 digits and separators	none
Normal disconnect batch file	(filename)	none
Abnormal disconnect batch file	(filename)	none
Inactivity time-out	0–999	0
Failsafe disconnects	on, off	on
DLE-EOT disconnect***	on, off	off
EOT disconnect	on, off	off
Print completions	on, off	off
Remote commands	on, off	on
Remote device control	on, off	on

* DC1 is the Control-Q or XOFF character; DC3 is the Control-S or XON character.

** ABM is the answer-back message.

*** DLE is the ASCII "data-link escape" character; EOT is the ASCII "end-of-transmission" character.

Table 5: *TI's TTY Communications package allows the user to control a broad range of communications parameters. Note that the Busy-handling parameter's default is "None," while those parameters with no default are indicated by "none."*

F1 brings up a Help screen.

The remote-command capability deserves some mention. By enabling the remote-commands parameter, a remote computer can control the sending and receiving of files, as well as creating, renaming, and deleting files. The remote computer simply sends an escape character followed immediately by a 0 and a series of commands. For example, the following command line from a remote computer sets up the TI Professional Computer to receive a file named TEST.DOC:

```
<ESC>
0REC FIL=TEST.DOC<NL>
```

in which <NL> is the recognized received new-line character sequence. Although only the first three letters of a command are necessary, you must specify the full filename.

From a personal-computer user's point of view, the TI Professional still lacks a few things. When you upload files from this computer, your only protocol option is XON/XOFF. No provision exists for character echo or line-at-a-time transmission. Also, the system doesn't provide for any kind of block transmission with error checking and retransmission upon detection (`a la Ward Christiansen). This wouldn't be so bad if you could exit from this program and call up MODEM7, but an exit causes the modem to disconnect.

The remote access of the TI computer is somewhat disconcerting because the operation is performed totally blind. There is no echo of the commands you enter, and, believe it or not, you cannot call up the Professional Computer's directory from a remote computer. Therefore, you must know the exact name of the file you wish to download.

One major question—how can a company produce such a beautiful piece of communications software and then render it practically useless with such an awful manual? I worked extensively with this program, includ-

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- *A roofing company in Green Bay, Wisconsin, computes job estimates, contracts, invoicing, and tracks actual costs with VersaForm.*
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ing several remote operations, and I'm still not sure how to use it to its fullest capacity. The section on remote commands is practically useless. Essentially it merely presents the commands; you must figure out how they're used. And the descriptions of some of the communications parameters are sparse, too.

Conclusions

After using the TI Professional Computer extensively for about five weeks, I have little doubt that it is superior to the IBM PC, both physically and electronically. The case is made of a heavier-gauge metal, the cover of the system unit detaches much more easily, the keyboard is of better quality and design, the display has a higher resolution, and thought has been given to preserving expansion slots for real peripherals. The system upgrades from a single floppy-disk drive to a 10-megabyte Winchester, and support is provided for high-density (96 tracks per inch) drives. You can increase memory from 64 to 748K bytes. The capability to produce color text is standard; with the optional graphics board, you can mix text and graphics on the same display. The interrupt structure is flexible, and the manufacturer supports the 8087 coprocessor option. Most of the major software packages have been adapted to run on this machine, including Lotus Development Corporation's 1-2-3 (which performs superbly on the TI because of its higher resolution and combined text and graphics).

But this machine is not for a novice; most of the manuals don't contain hand-holding tutorials. In some, you'll be lucky to find what you need. A helpful dealer who gets you started with this machine is vital. And remember, third-party hardware support is not nearly as robust as it is for the IBM PC. Tecmar Inc. (23600 Mercantile Rd., Cleveland, OH 44122), however, claims that it will offer TI-compatible versions of its IBM PC boards.

So what does this mean for the purchaser of a TI Professional Computer? For now, you'll get most of your peripherals from TI, and you're limited to what they offer. However, TI plans to introduce the much-discussed voice system, a combination speech-digitizing, store, and forward system capable of serving as a kind of high-class phone-answering machine that will also be capable of speech recognition. A 512K-byte memory board that will increase the total system RAM to 768K bytes is due by year end. An analog/clock card has been designed and documented in the technical manual, but no release date is available. This card will support two joysticks, four paddles, switches, and a light pen, in addition to a clock/calendar.

With a lot of hard work and a little luck, TI has a chance to capture a significant portion of the high-end personal-computer market. Although its computer may appear to be just another IBM clone, a closer look reveals a machine that is superior in many ways. It definitely invites a closer look.■

Mark Haas is technical director at Osborne/McGraw-Hill (2600 Tenth St., Berkeley, CA 94710).

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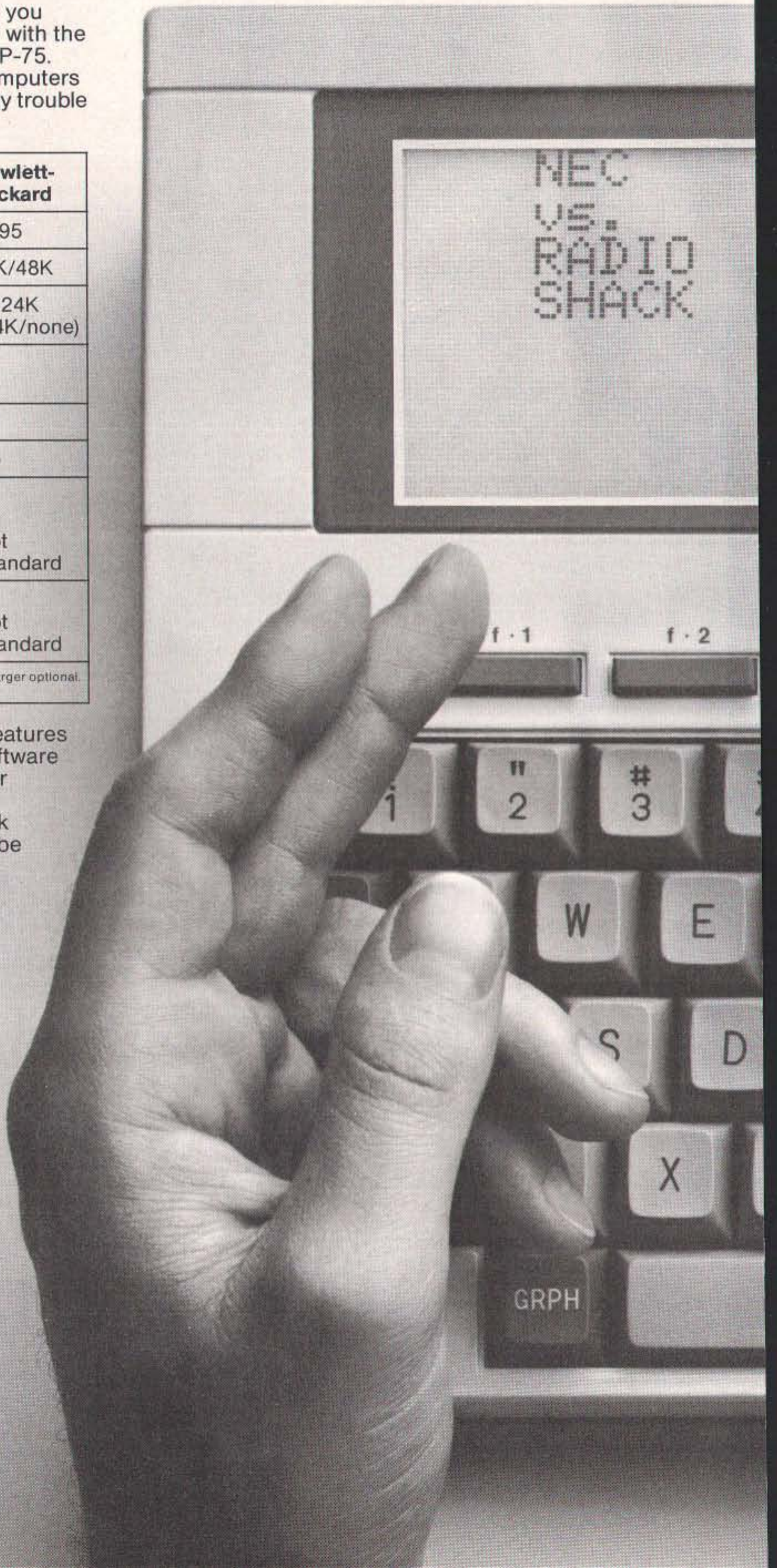

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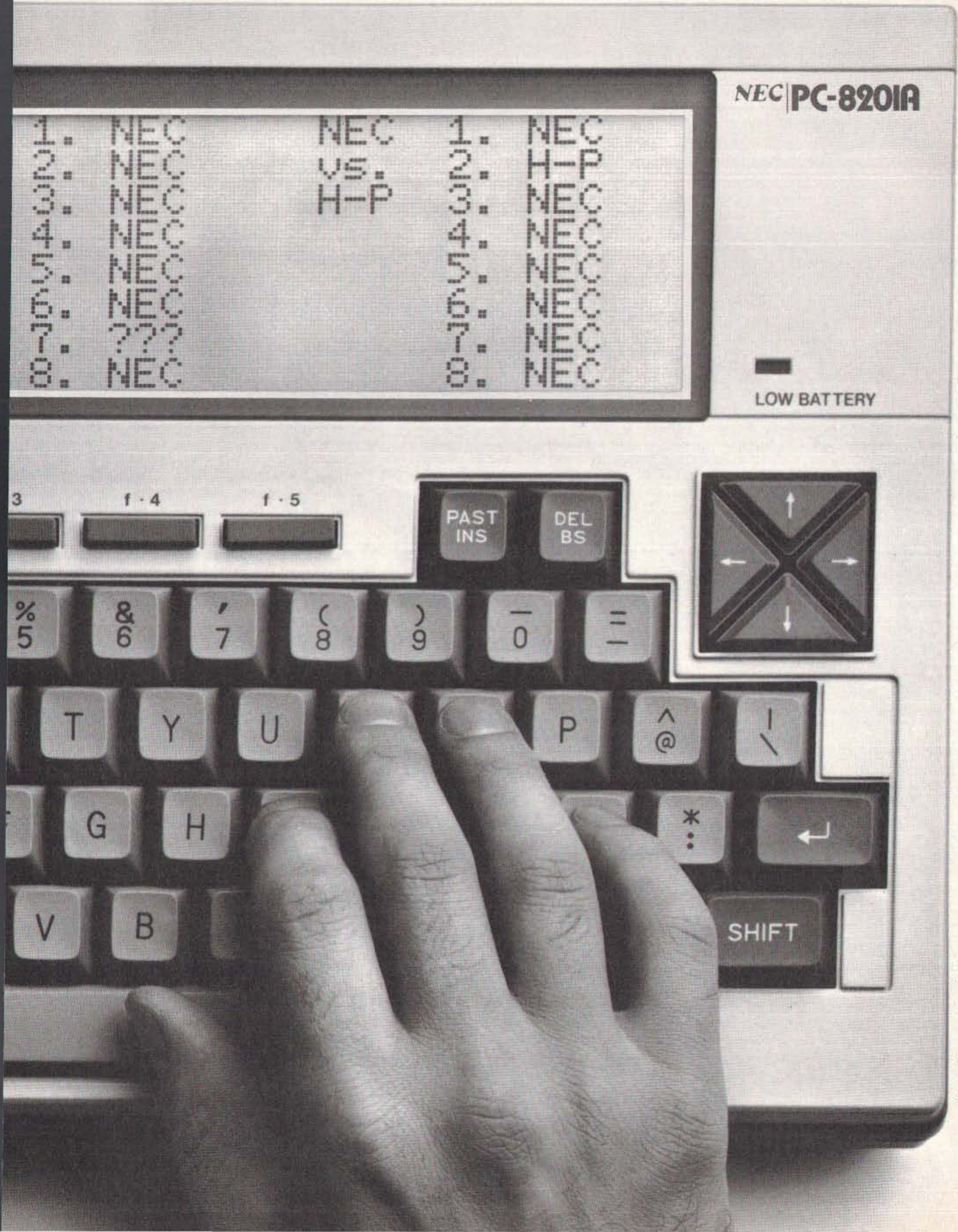

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Hardware Review

The ATR8000

This Z80 computer/peripheral enables Atari users to run CP/M-based programs

by Dave Small and Sandy Small

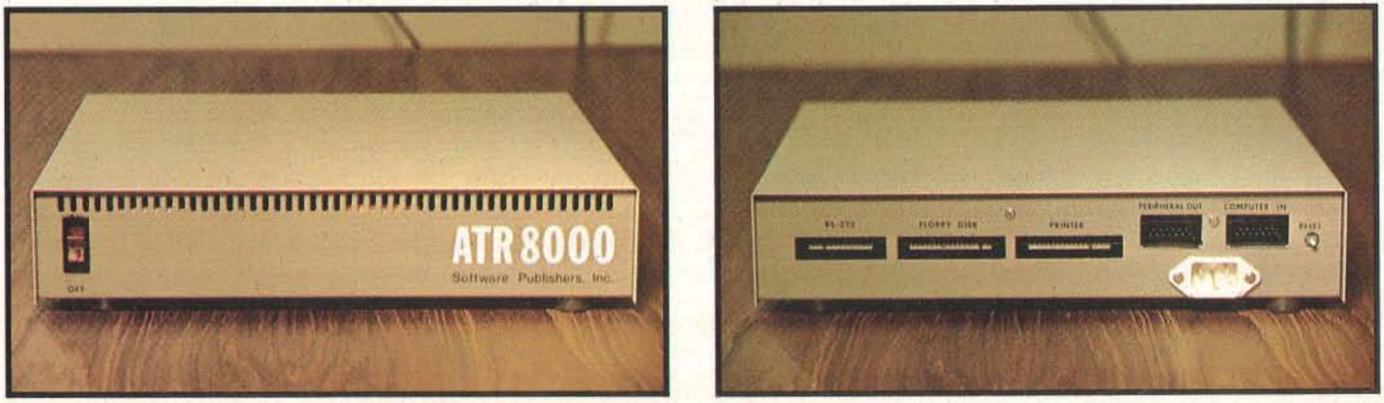
Capable of serving as an intelligent peripheral or as a stand-alone computer, the ATR8000 should prove to be of interest to Atari users because it enables them to access CP/M-based applications programs. It should also prove of interest to anyone looking for a machine that can run CP/M-80, CP/M-86, or MS-DOS.

The ATR8000, manufactured by SWP (formerly Software Publishers Inc.), owes its potentially wide appeal to its availability in four configurations. The lowest-priced version ($350) employs 16K bytes of RAM (random-access read/write memory), 4K bytes of ROM (read-only memory), and a Z80 processor. Intended to serve as an Atari peripheral, this model can readily interface Atari computers with a host of additional peripherals, including standard-bus disk drives and devices with Centronics parallel or RS-232C serial ports. When used to interface a printer to an Atari, the ATR8000 allocates a 12K-byte buffer for printer-spooling operation.

The intermediate and two top-of-the-line configurations can serve as stand-alone computers. The stand-alone versions can interface with standard terminals such as those offered by Televideo Inc. or use an Atari computer as a terminal.

The intermediate configuration ($550) includes a Z80 processor and 64K bytes of RAM, which makes it capable of running the CP/M 2.2 operating system configured for 60K bytes of RAM. When used as an Atari peripheral, this configuration's 64K-byte RAM can be used as an additional printer-spooler buffer area.

Each of the two top-of-the-line models ($800 or $1050 added to the $550 price of the intermediate version) incorporates an 8088 16-bit processor and either 128K or 256K bytes of RAM in addition to the Z80 and 64K bytes of RAM; these configurations can run the MS-DOS and CP/M-86 operating systems, enabling the ATR8000 to handle software available for the IBM Personal Com-


(1a)

(1b)

Photo 1: *Front (a) and rear (b) views of the ATR8000. The rear connections shown in photo 1b are, from left to right, an RS-232C serial I/O port, a 34-pin floppy-disk connector, a 34-pin parallel printer port, and Atari serial I/O daisy-chain-out and -in connectors. A Reset button is located to the right of the daisy-chain connectors; the power connector is located directly below them.*

puter. In these 8088-based configurations, the 128K or 256K bytes of RAM associated with the 8088 processor can serve as a disk emulator that can be accessed by the Z80 processor, resulting in extremely fast disk-type I/O (input/output).

The Atari Peripheral Configuration

As an Atari peripheral, the ATR8000 plugs into the serial bus that the Atari uses to communicate with I/O devices. The ATR8000 is thus daisy-chained onto this serial bus, as are all Atari peripherals. This Atari serial bus uses a nonstandard 19.2K-bits per second communications protocol. All Atari devices that use this serial bus require some sort of processor to decode or encode data out of or into this data format. For instance, Atari uses a 6507 microprocessor to perform this task in its disk drives and Model 850 interface.

Unfortunately, this added encoding/decoding-hardware requirement increases the cost of Atari peripherals. Eliminating this requirement, the ATR8000 interfaces the Atari serial bus to a number of standard peripherals. (The term "standard" here means the de facto pin-out standards that the peripheral industry has more or less adopted in the interest of compatibility.) Among the better known "standards" are the 25-pin RS-232C serial bus, the 36-pin Centronics-type parallel bus, and the 34-pin (5¼-inch) or 50-pin (8-inch) disk bus.

The first, most important peripheral is a disk drive. Up to four single- or double-sided, 8- or 5¼-inch, single- or double-density drives can be plugged into the ATR8000. Moreover, the ATR8000 permits several track formats. The range of possibilities is nearly endless, given today's drive market; the ATR8000 can use almost any drive that has the standard 34-pin bus connection used by Tandon, Shugart, MPI, and others. An adapter, available from SWP for $19.95, interfaces the ATR8000 to units employing the 50-pin standard 8-inch drive connector used by Shugart, Siemens, and Qume.

The disk-interfacing capability alone makes the ATR8000 a good buy from the Atari owner's point of view; until now, standard disk drives, lacking the capability to decode the signals on the Atari serial bus, could not be connected to the Atari. Until recently, the only Atari-compatible drives available have been the Atari 810, a single-density unit, and a few similar drives. Because of the hardware needed for the Atari's bus, the 810 lists for $599, which is quite steep for a 5¼-inch single-sided single-density drive.

The 810 also suffers from design and reliability problems. The first problem involves use of a serial bus to transfer data. Although the bus runs at 19,200 bits per second, the handshaking slows the effective data-transfer rate considerably. The serial bus is extremely quiet according to radio-frequency interference standards, but the data-transfer rate is four to eight times slower than that of other systems. There are also rpm-regulation and data-separation problems that reduce the 810's capability to read disks accurately.

Finally, the 810 is a single-density disk drive. As Atari and Osborne owners have discovered, the 90K-byte capacity of such drives doesn't allow much data storage, especially when compared to other double-density double-sided, 80-track drives that offer 160K to 500K bytes of storage.

A few manufacturers are marketing replacements for the 810. Other manufacturers offer disk-drive mechanisms and cases with much better reliability than the 810's mechanism. A 5¼-inch Tandon TM-100 drive with case and power supply sells for $200 to $250. Our experience indicates this is a very reliable drive; for instance, speed is regulated within 1 percent, a far cry from the 10 percent drift found in many Atari drives. But these "raw" drive mechanisms lack the circuitry to connect to the Atari serial bus. With the ATR8000, however, these standard drives can be driven from the Atari.

The ATR8000 offers many features in addition to disk-drive interfacing. First, it provides a Centronics parallel and an RS-232C serial port. Until now, Atari owners needing to interface to a parallel or serial device required an Atari 850 interface, which connects the Atari serial bus to these devices. The 850 retails for $219.

Second, the ATR8000 printer port is buffered, which enables the Atari to dump data as fast as it can and go on to other things while the ATR8000 handles the printing operations. A typical 16K-byte buffer retails for $149.

Third, the ATR8000 handles double-density disk storage of 180K bytes (assuming a single-sided 40-track drive), a significant increase over the 810's 90K bytes. Percom's dual-density disk drive for the Atari retails for $699 (single-drive unit), or $100 more than the Atari drive. Thus, for $575 ($350 for the ATR8000 and $225 for a TM-100 disk drive with case) you're getting performance that would otherwise cost $1067—$699 for a Percom dual-density drive, $149 for a 16K-byte buffer, and $219 for a Model 850 interface.

The ATR8000 readily accommodates increases in disk-storage capacity. To upgrade to a two-drive system, for example, only a $225 drive mechanism need be added to the ATR8000. For an Atari drive, a whole new drive plus a controller board must be added—a $699 cost.

A New Operating System

One problem that arises when using the ATR8000 as an Atari peripheral is that the Atari's disk operating system (DOS) is not configured to handle more than 720 sectors per disk, although it can handle single- or double-density sectors (128/256-byte sector sizes). Consequently, a new operating system is needed to handle 8-inch or other high-capacity disks. SWP offers MYDOS, an operating system capable of handling these large-capacity drives. It should be noted that copy-protected Atari software and any software with a custom DOS will not take advantage of the added space of higher-capacity drives that the ATR8000 can use. But for applications that use a new DOS, the ATR8000 and MYDOS offer a helpful tool.

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At a Glance

Name
ATR8000

Manufacturer
SWP (formerly Software Publishers Inc.)
2500 E. Randol Mill Rd., Suite 125
Arlington, TX 26011
(817) 469-1181

Size
11½ by 12½ by 2½ inches; 8 pounds

Features
As an Atari peripheral, the ATR8000 interfaces the Atari serial bus to devices with RS-232C serial or Centronics parallel ports as well as to disk drives with standard bus interfaces; this version includes 16K bytes of RAM. As a stand-alone computer, the ATR8000 comes in versions with 64K to 256K bytes of RAM; a Z80-based version runs CP/M-80; and an 8088-based add-on (Co-Power-88) enables the ATR8000 to run CP/M-86 and MS-DOS

Hardware required
Interface cabling and connectors, available from SWP or other distributors

Software required
Atari DOS to use the ATR8000 as a peripheral; CP/M-80, MS-DOS, or CP/M-86 are provided with ATR8000 configurations that support those operating systems

Documentation
73 pages

Options
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Interfaces

The ATR8000 supplies Centronics and RS-232C interfaces for the Atari. Both are edge connections and accept the usual clamp-on ribbon connectors. The parallel connection runs via a flat ribbon cable to a standard 36-pin Centronics parallel-interface connector. The RS-232C connector comes out to a 26-pin edge connector that hooks via a flat ribbon cable to the popular DB-25 connector. The pin connections that have become standard for RS-232C data transmission are used: 2 and 3 for data, 4 and 5 for handshake, and so forth. If you need to swap the two pairs of lines, the ATR8000 provides an internal jumper header that allows you to change them easily.

We were pleasantly surprised to find that the ATR8000 worked the first time when connected directly to an Okidata Microline 84 (a parallel printer) and a Hayes Smartmodem (a serial device). The total interfacing took only 10 minutes, which were spent clamping connectors onto ribbon cable.

In its smallest configuration, the ATR8000 ranks as a "best buy" for Atari owners who want to expand their systems with disk drives, parallel printers, and serial RS-232C devices.

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The CP/M Configuration

The ATR8000 configured as a stand-alone computer uses the Atari as a terminal. If you do not own an Atari, any RS-232C device capable of running at 9600 bits per second will suffice. We used a Lear Siegler Inc. ADM 3A terminal for some time. You must move three jumpers in the ATR8000 depending on whether an Atari or an RS-232C terminal is used.

This configuration of the ATR8000 comes equipped with 64K bytes of RAM, 60K bytes of which are available as system RAM. A 4K-byte section is mapped into a 2732 EPROM (erasable programmable read-only memory) containing the Atari disk-emulation code and a monitor, used to boot up CP/M. CP/M 2.2 from Digital Research is supplied on either a 5¼- or an 8-inch disk.

The hardware difference between this ATR8000, a full CP/M machine, and the 16K-byte version, which is an Atari-only peripheral device, is in the memory upgrade (larger dynamic RAMs) and internal jumpers. The cost of this upgrade to an end user is $200. Now, to a knowledgeable computer user, paying $200 for upgrading 4116 RAM chips to 4164s (× 8) seems a bit out of line. However, for that price, SWP is supplying not only the new RAM chips but also a licensed copy of CP/M, all the CP/M utilities, CP/M manuals (a thick stack), and, most of all, support.

Of course, if you still want to use your ATR8000 as an Atari interface, it will work as such in its 64K-byte configuration. The only difference is that 58K bytes, instead of 12K bytes, are available for print spooling. Unless the ATR8000 is specifically booted into CP/M, it remains an Atari peripheral.

In CP/M mode, the Atari serial bus direction is reversed, and the ATR8000 becomes a stand-alone computer; the Atari becomes a terminal instead of serving as the primary computer.

There is, however, a disadvantage to using the Atari as a terminal. The Atari's video-generator chip has a text-window resolution of 40 characters across by 24 characters high. (This format is consistent with 160 color clocks on an average TV screen; TVs do not have the bandwidth needed to run 80 characters across.) Hence, when the Atari is used as the I/O device for the ATR8000's CP/M, a 40-column screen is supported.

The system comes with software to make the Atari emulate an 80-column ADM 3A terminal with a scrolling window. With this technique, 80 characters across are maintained internally, and 40 of the 80 are shown on the text screen. The user can manipulate the window with keys and has the option of having the window follow the cursor across the screen, a rather dizzying effect.

If the Atari 800 is equipped with an 80-column video card, such as the Bit-3 Full-View 80, then true 80-column CP/M can be used. Interfacing is straightforward. Our system, for instance, has the Bit-3 board and a PI 3 monitor and functions very well. The Bit-3 board for the Atari 800 retails for $349.95. A typical monitor capable of 80-column display costs $150. (For details on the

80-column board, contact Bit-3 Computer Corp., 8120 Penn Ave. South, Suite 548, Minneapolis, MN 55431.)

The CP/M system is booted in a two-step process. The booting process illustrates the operation of the ATR8000 system, so let's go into it in detail.

First, turn the ATR8000 on. Any disk drives connected to the ATR8000 are restored to track 00, then stepped out five tracks. (We wondered why this was done until we found out that some disk drives can get the disk head caught behind the track 00 sensor. The five outward steps prevent this problem (an impressive "user helpful" feature). The drive's index pulses, from the index hole on the disk, are sensed and timed; if the index pulses indicate an rpm of 300, the drive is logged as a 5¼-inch drive. If the rpm is 360, the drive is logged as an 8-inch drive. Internal tables are set accordingly (for example, the single-density format command is told to place 18 sectors on a 5¼-inch track and to put 26 sectors on an 8-inch track; this boot-timing process determines which format is used).

The step rate of the drives is determined automatically at boot time, and the drives are run at the fastest rate at which they can be stepped. Because this rate varies widely between drives, automatic stepping timing is a real convenience; it makes the ATR8000 capable of using a wide range of drives without the user having to worry about step rates, settling times, and so forth, which vary so widely across the industry. If you have a drive only intermittently capable of running at high speed, however, you can force a slower default stepping speed on a particular drive by using the DDSYSGEN editor. (We had a problem with one of our 8-inch drives that has been around a long time; it could not always step at high speed, so we slowed down the stepping to the next available rate.)

Next, the ATR8000 settles down into Atari-emulation mode, in which it accepts normal Atari commands from the serial bus and executes them. For example, disk I/O requests are sent to the proper drive, printer requests are sent to the printer, and so on.

At this point, the ATR8000 is usable as an Atari disk drive. Next, let's boot CP/M.

Let's assume you have put the Autoterm-ADM 3A Emulator disk in the ATR8000's drive 1 and started up the Atari. Acting as an Atari disk drive, the ATR8000 reads in the emulator and sends the program to the Atari. The Atari then starts acting as a terminal, "watching" the serial bus for communications. At this point, the serial bus is turned around; the ATR8000 is the primary computer and the Atari is the terminal.

The ATR8000 is reset by the user via the back-panel Reset button, which sends it out of Atari disk-emulation mode. The ATR8000 displays the message ATRMON, which indicates that the system is running a small monitor, in ROM, in the ATR8000.

At this point, you're just about ready to run CP/M; remove the Autoterm-ADM 3A Emulator disk and insert any disk with the CP/M operating system into drive 1 (A). Next, type in B. This command initiates the boot process from drive 1. In 2 or 3 seconds the familiar 60K CP/M 2.2 and A> messages appear on the Atari's screen.

If you are running with a terminal other than the Atari, the CP/M boot process is a single step; you put the CP/M system disk into drive 1, switch on the ATR8000, type in B, and boot directly. The difference is in using the ATR8000 to load the Atari's terminal program.

What is so impressive is the ease of this whole process. The ATR8000 determines drive size, density, sector size, and so forth, by itself, with no user intervention. You do not need to keep the system on a 5¼- or an 8-inch disk, nor do you need to permanently keep one kind of drive as A. Furthermore, programmers at SWP have allowed the use of 1024-byte sectors, which are internally deblocked to eight 128-byte sectors. The use of 1024-byte sectors is extremely efficient; in a 1024-byte disk format, most of the track is taken up with the data, not a number of sector headers and other nondata overhead. This format, by minimizing disk accesses, speeds everything up. In a typical input or output operation, another disk access is not needed until all 1024 bytes are processed. This compares with eight disk accesses on a single-density, 128-byte-sector (standard CP/M) system.

The ATR8000 determines drive size, density, sector size, and so forth, by itself, with no user intervention.

Because of the lowered amount of sector header information, the 1024-byte-sector format is recommended. This format fits 180K bytes of data on a 5¼-inch disk and 674K bytes on an 8-inch disk, assuming double density. If you use double-sided drives, the capacity increases to 360K bytes on a 5¼-inch drive and 1.3 megabytes on an 8-inch drive.

From CP/M, many disk-track-layout formats are available, in either 5¼- or 8-inch disks:

- 128 bytes/sector, single density (the standard 8-inch disk format)
- 256 bytes/sector, double density (a common double-density format)
- 512 bytes/sector, double density (suitable for reading TRS-80 Model II 8-inch disks)
- 1024 bytes/sector, double density (the usual SWP format, allowing 674K bytes of storage on a single-sided 8-inch disk)

SWP's DDINIT program initializes a disk to any of these configurations, and the software automatically adjusts for the new sector sizes.

The ATR8000 can read disk formats of several manufacturers, including those of IBM, Kaypro, Osborne, and the Xerox 820. Configuration programs are available to read disks with nonstandard interleaving or sector size. We found these programs extremely useful; we had a library of Osborne disks, with their 90K-byte limit, and data spread across those disks that we wanted in one place. We copied about 30 Osborne disks down to three double-density 8-inch disks and had room to spare.

If you change disk density or sector size with a disk swap, a simple Control-C command will reset the ATR8000's internal tables, and upon the next disk access to the drive involved, the ATR8000 will reconfigure itself and the CP/M blocking/deblocking tables for the proper density and sector size.

We ran one rather unfair test of the ATR8000 just to see how far the software would go. We formatted a disk with half double-density and half single-density tracks on it and then started copying programs onto it. The system reached the track with the changed density; once the system "found" the new density areas on the disk, it reset the internal tables and continued writing. At this point, we gave up trying to find ways to beat the ATR8000.

Our ATR8000 system has two 8-inch Shugart 800 drives and one 5¼-inch Tandon TM-100-1 drive. Operation under CP/M and Atari DOS has been flawless. Any number of copy operations from 5¼- to 8-inch and vice versa, density changes, and strange disk formats have operated with no problems. In other words, the ATR8000 disk firmware has been thoroughly debugged.

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The CP/M software we've used with the ATR8000 includes Wordstar, Microsoft BASIC, Supercalc, and SMODEM37. All have performed without any problems. There is probably no CP/M system on the market that is easier to use. For instance, take the automatic drive configuration. When the ATR8000 is booted, it determines drive and sector size, density, and step rate automatically.

For most CP/M users, these things do not happen automatically. Most of them must be done by (usually) modifying the CP/M BIOS (basic input/output system), which involves editing and reassembling source code—no small task for a novice user. Generally, the user must configure the floppy controller-board software for drive step rate, size, number of tracks, and so on. The user must also configure CP/M for sector and disk size, setting up a number of tables for each new drive. Frankly, this is a miserable process and tedious even when you have been through it before; for a beginner, just understanding the CP/M parameter tables is nearly impossible.

But the ATR8000 does all of this automatically. We have changed drive configurations and densities many times and never once touched the BIOS. Because you can hook up almost any disk drive and use the drive without problems, the ATR8000 may be an ultimate CP/M system.

If you need a low-level disk analyzer, SWP offers Diskmon and supplies it to every CP/M customer. This sector-level disk editor is helpful for recovering data from bad disks and for fixing directories. SWP also supplies SMODEM37, a user-friendly telecommunications program configured for the Hayes Smartmodem and the ATR8000. (SMODEM37 is a public-domain program developed by the prolific Ward Christiansen and the CP/M User's Group.) We have used it for some time with Compuserve, The Source, and many bulletin boards and found it to be an excellent and friendly modem program. Such features as checksummed object-code transmission and reception, printer on/off, and a variety of data-transmission rates make it a powerful and useful tool.

The vendor documents all of these utilities in a well-written 70-page manual that also covers the parameters needed for the context editor and how to hook the system up to various disk drives. SWP also sends updates to its customers, and some errors in the manuals have been corrected. In general, the documentation is above average.

The 8088 Configuration

Internally, the ATR8000 is a standard 4-MHz Z80 system. A Mostek Z80 is the central processor, and 64K-bit or 16K-bit dynamic RAMs are used for memory. The other major chips include the standard Z80 CTC and the Western Digital 1797.

With the advent of the IBM Personal Computer (PC), the 8088 suddenly became a very popular processor. Because IBM is selling so many PCs, there is a great demand for 8088 software, and already many of the

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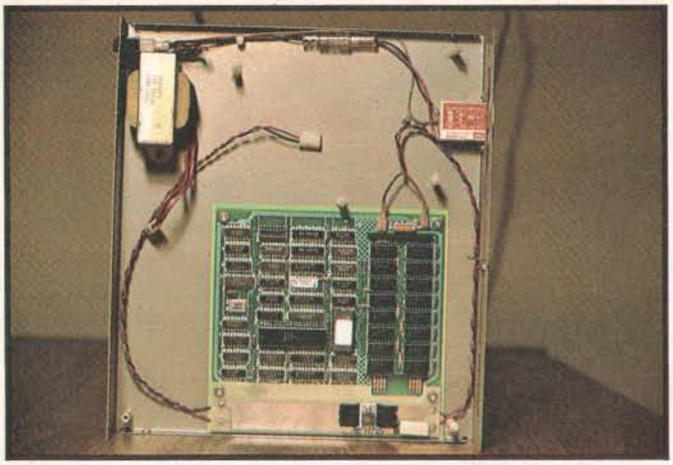

Photo 2: *The Co-Power-88 main processor board, mounted on the ATR8000's bottom tray.*

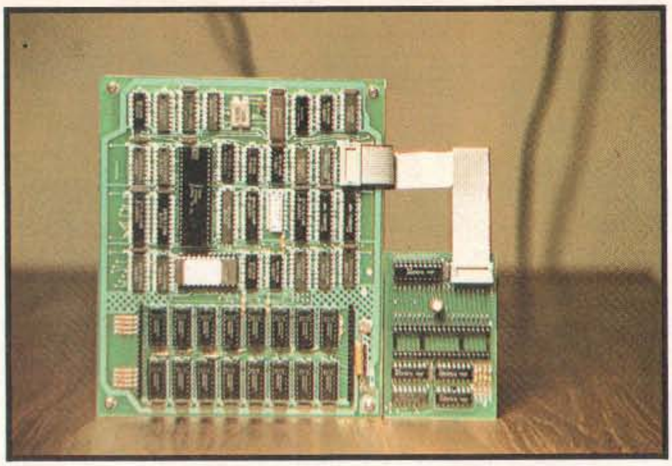

Photo 3: *The Co-Power-88 main processor board and Z80 adapter board.*

popular applications programs for CP/M-80 have been translated for the 8088 (Wordstar-86, Supercalc, and others). With this potentially large software market in mind, SWP developed the Co-Power-88 (photo 2), a stand-alone 8088 processor with either 128K or 256K bytes of memory, accessible through the ATR8000's own Z80. The 8088 is clocked at 5 MHz and runs under either MS-DOS from Microsoft or CP/M-86 from Digital Research.

The Co-Power-88, designed to provide Z80A-based CP/M 2.2 systems with the power of the 8088, plugs into the Z80's socket via a piggyback scheme. The Z80 is first removed, then an adapter (photo 3) is plugged into the Z80's socket and the Z80 is plugged into the adapter. The adapter gives the Z80 two new I/O ports, located at FE and FF hexadecimal, although the port locations are reconfigurable if those locations are already in use on your system. These two ports are then led via a short cable to the 8088 board; all communications between the 8088 and the outside world are through this cable.

This generic method of interfacing an 8088 to a Z80 can be applied not only to the ATR8000 but to many other Z80 systems. Given the number of users who will want to upgrade their Z80 systems to the 8088, this technique seems like an excellent way to go. SWP is planning on releasing the Co-Power-88 for a variety of Z80A-based CP/M machines in the near future and will probably sell a generic version for users wanting to install an 8088 themselves.

The CP/M-80 system runs normally with the Co-Power-88 installed. However, 120K or 250K bytes of Co-Power-88 RAM can emulate a disk drive, a very useful capability for spreadsheet manipulation, database sorting, and skimming through documents with Wordstar. This M-drive, as SWP refers to it, removes disk access delay time and greatly speeds up the CP/M system.

The Co-Power system is easy to boot. When "Z88 (return)" is typed, the 8088 seizes control of the user's CP/M system and boots off the main disk. The user's Z80 BIOS, and the Z80 as a controller, are used for input and output to the 8088. Hence the Co-Power-88 system is machine-independent because it uses the CP/M BIOS already written and containing the machine-dependent routines for all of its I/O functions.

CP/M-86 is available with the Co-Power-88 through SWP. Programs that run on the IBM PC should work with the Co-Power-88 if they don't rely on IBM-dependent features (direct ROM calls and so forth).

The Co-Power-88 is an excellent upgrade to CP/M-80 systems using a Z80 processor. It installs easily because it uses the CP/M routines already written. For users needing the large address space of the 8088 and who already have a CP/M-80 based system, the Co-Power-88 is well worth looking into.

Conclusion

The ATR8000 offers three levels of expansion. For the Atari, it provides a clean interface to disk drives, printers, and serial devices; for an Atari user or for any user with a terminal, it provides access to the CP/M marketplace's vast software supply and it offers the capability to access the growing 8088 software market.

The ATR8000 offers another form of expansion: future compatibility. The Atari's 6502 is an 8-bit processor in an increasingly 16-bit world. With the ATR8000, an Atari owner can begin to use CP/M-86, MS-DOS, and 16-bit 8088 software now.

A fine CP/M machine with extremely user-friendly disk interfacing, the ATR8000 is ideal for CP/M users who want to get their systems running without problems. It is a true turnkey system—one of the very few we have encountered. The ATR8000 closes the gap that has separated Atari owners from the rest of the software market.■

Dave and Sandy Small (11314 Yucca Dr., Austin, TX 78759) are computer consultants. Both have degrees in computer science from Colorado State University.

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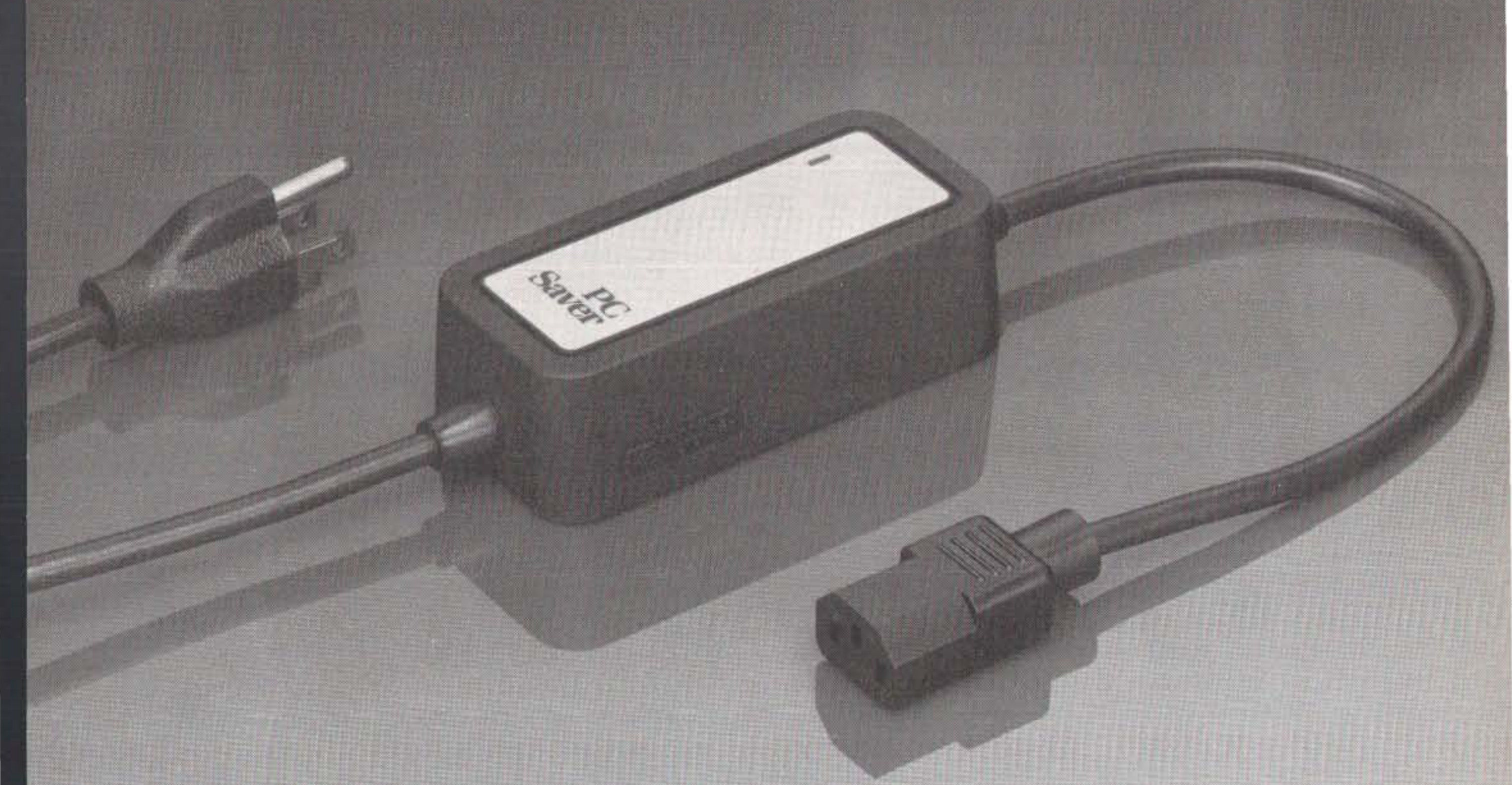

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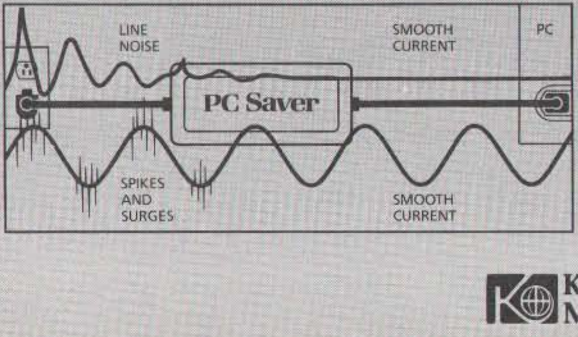

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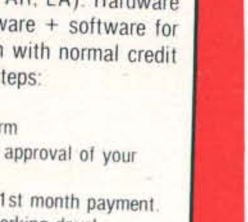

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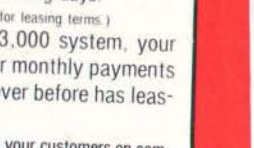

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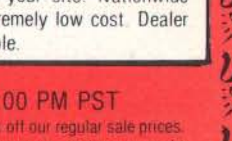

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The Hercules Graphics Card

This card connects directly to the display and provides high-resolution graphics for the IBM PC

by Tom Wadlow

When I bought an IBM Personal Computer (PC), I spent quite a bit of time comparing the merits of the monochrome display with those of the color display. One side of the debate asked: How can you have a home computer without some sort of graphics display? Look at all the flexibility you'd have, writing color-coded software and making graphs and charts. And what about games? The other side of the debate was, unfortunately, much more pragmatic: Are you going to be able to stare at color characters on the display all day?

Pragmatism won.

But now there's a product for people who want crisp, attractive text as well as graphics. Hercules Computer Technology's Graphics Card (see photo 1) directly replaces the IBM monochrome card; it plugs into a slot in the IBM backplane and connects to the PC display (i.e., the green-phosphor video monitor). The card produces a display that is indistinguishable from that of the standard monochrome board. Twiddle a few bits, however, and the card provides a 720- by 348-point graphics display as well. In addition, the Hercules card has two displayable graphics pages. Because you can write into one page while displaying the other, some types of animation are possible.

The Hercules board looks and feels well constructed. It's a full-sized PC board that comes with an extra card guide. The board's connectors duplicate those of the IBM monochrome card—one for connection to the IBM monitor and one for the parallel printer interface. To use this board with a standard video monitor, you would prob-

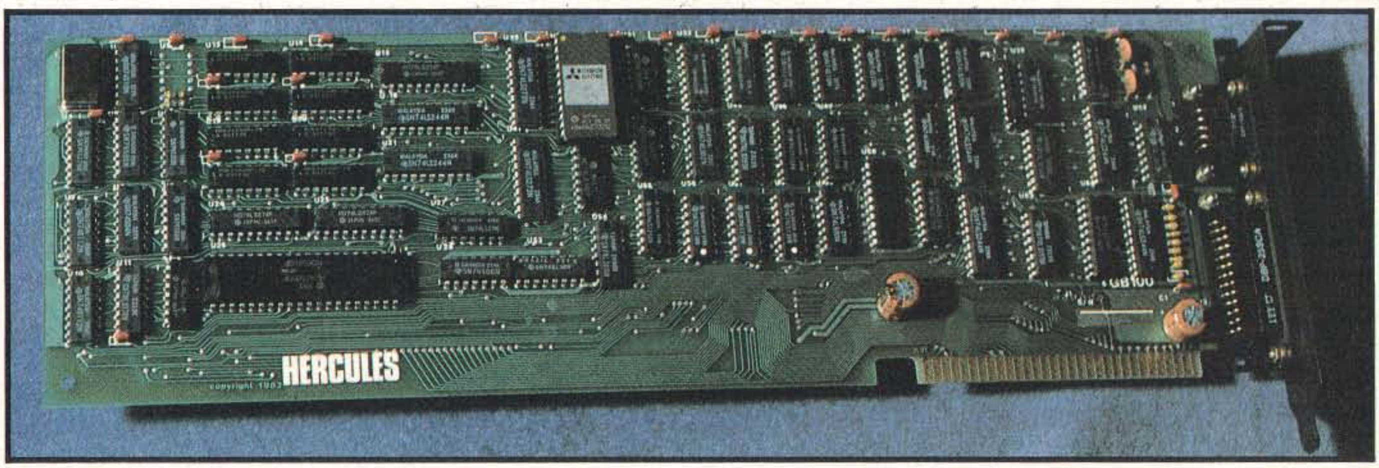

Photo 1: *The Hercules Graphics Card plugs into a slot on the IBM PC's backplane, replacing IBM's monochrome card.*

Command	Operation
GMODE	Enters graphics mode
TMODE	Enters text mode
CLRSCR	Clears the current graphics page
GPAGE	Sets the current graphics page for writing (either 0 or 1) but doesn't affect the display
LEVEL	Sets the intensity level for subsequent writing; 0 writes black (off), 1 writes white (on), 2 applies the exclusive-OR function to what is on the screen
DISP	Sets the currently displayed graphics page
PLOT	Writes one pixel to the screen
GETPT	Gets one pixel from the screen
MOVE	Sets an endpoint to be used for line drawing
DLINE	Draws a line from the point set by the last MOVE to the current point
BLKFIL	Fills a rectangle according to the currently set intensity
TEXT	Puts a character or characters on the screen
ARC	Draws a quarter circle
CIRCLE	Draws a complete circle
FILL	Fills in an irregular polygon

Table 1: *The graphics primitives supplied with the Hercules card.*

At a Glance

Name
Hercules Graphics Card

Use
Replaces the IBM monochrome display card; has both 80- by 25-character display and 720- by 348-point graphics display

Manufacturer
Hercules Computer Technology, 3200 Adeline St., Berkeley, CA 94703, (415) 799-9354

Size
Uses one slot on the IBM PC backplane

Features
Text display is indistinguishable from that of the IBM monochrome display; includes a printer port to allow replacement of the monochrome card

Hardware required
IBM monochrome video display; **cannot** be used in conjunction with a color display

Software
BASICA, in order to run HBASIC; can be used with high-level languages as well, although none is provided

Documentation
General description of hardware, low-level graphics interface routines, and BASIC

Price
$499, includes Graph X and HBASIC software

ably need an adapter cable.

Replacing my monochrome board with the Hercules presented no problem because the operations manual contained explicit instructions. The Hercules card worked the first time, pretending to be the standard 80- by 25-character text display. With daily use, however, I have noticed an occasional failure to properly initialize on power-up; specifically, the cursor does not appear as it should, and the system does not boot. Each time this problem occurred, I solved it by turning off the system power switch, waiting a few seconds, and then turning the system back on.

I made working copies of the two Hercules disks so I could try out the graphics functions. A message on the disk envelope warns the user that only *one* backup copy is permitted, although this rule is not enforced by the software. It seems ridiculous to place such an unenforceable restriction on a software package, especially considering that the graphics functions are likely to be used in several ways on the same system. I'm sure that few people will endure the shuffling of floppy disks that's necessary to comply with this rule.

Graphics

The Hercules card provides a set of 15 graphics primitives, which can be called from BASIC, from assembly language, or from other high-level languages. Using these primitives as a starting point, you can write sophisticated programs to manipulate a screen image. The functions supplied are listed in table 1.

The Graph X software manual, which describes the graphics operations, contains excellent examples of the assembly-language interfaces needed to call these functions from an assembler program. An object file can be used with the IBM linker to enable compiled languages to use Graph X. Graph X functions can be called from BASIC—both IBM's BASICA (the Advanced BASIC interpreter provided by IBM for the PC) and compiled BASIC—through a series of steps.

HBASIC

Probably the easiest way to start producing graphics with the Hercules card is using Hercules BASIC (HBASIC). When I first heard about HBASIC, I had visions of trying to keep track of which .BAS files were written for BASICA and which were written for HBASIC. My fears, however, were unfounded. The program called HBASIC is *not* a new BASIC. It loads BASICA and modifies it in memory (not on disk) to do graphics, but it is somewhat different. Because it is slightly slower than BASICA, timing loops must be recalculated. BASICA assumes an individual character size of 8 by 8 pixels, yet HBASIC assumes a matrix of 9 by 14 pixels. Many graphics commands intended for the IBM color/graphics

Text continued on page 352

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Circle 421 on inquiry card.

Listing 1: *This IBM Macro Assembler program contains all the code needed to call any Graph X function. The program was used to generate a series of screens, from which some of the photos in this article were generated.*

```
TITLE Hercules  -- Exerciser for the Hercules Graphics Card
COMMENT *
        Written by Tom Wadlow
        *
video   macro   func            ; Do BDOS Screen output function func
        mov     ah,func
        int     10h
        endm

gmode   macro                   ; Enter graphics mode
        video   40h
        endm

tmode   macro                   ; Enter text mode
        video   41h
        endm

clrscr  macro                   ; Clear the screen
        video   42h
        endm

gpage   macro   bufpage         ; Change page to be written into
        mov     al,bufpage      ; (0 or 1)  Doesn't affect display
        video   43h
        endm

level   macro   i               ; Set intensity level
        mov     al,i            ; 0 - black, 1 - white, 2 - XOR
        video   44h
        endm

disp    macro   bufpage         ; Set current display page
        mov     al,bufpage      ; (0 or 1)
        video   45h
        endm

plot    macro   x,y             ; sets, clears or xors a pixel
        mov     di,x
        mov     bp,y
        video   46h
        endm

getpt   macro   x,y             ; reads a pixel
        mov     di,x
        mov     bp,y
        video   47h
        endm

move    macro   x,y             ; set new endpoint
        mov     di,x
        mov     bp,y
        video   48h
        endm

dline   macro   x,y             ; draws from last endpoint to x,y
        mov     di,x            ; sets new endpoint at x,y
        mov     bp,y
        video   49h
        endm
```

Listing 1 continued on page 350

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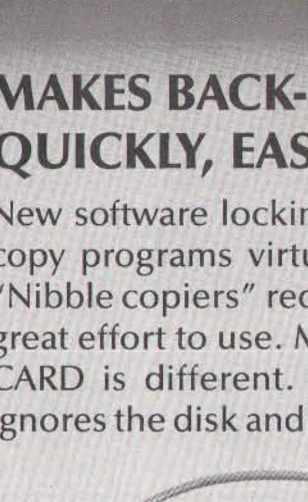

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Circle 164 on inquiry card.

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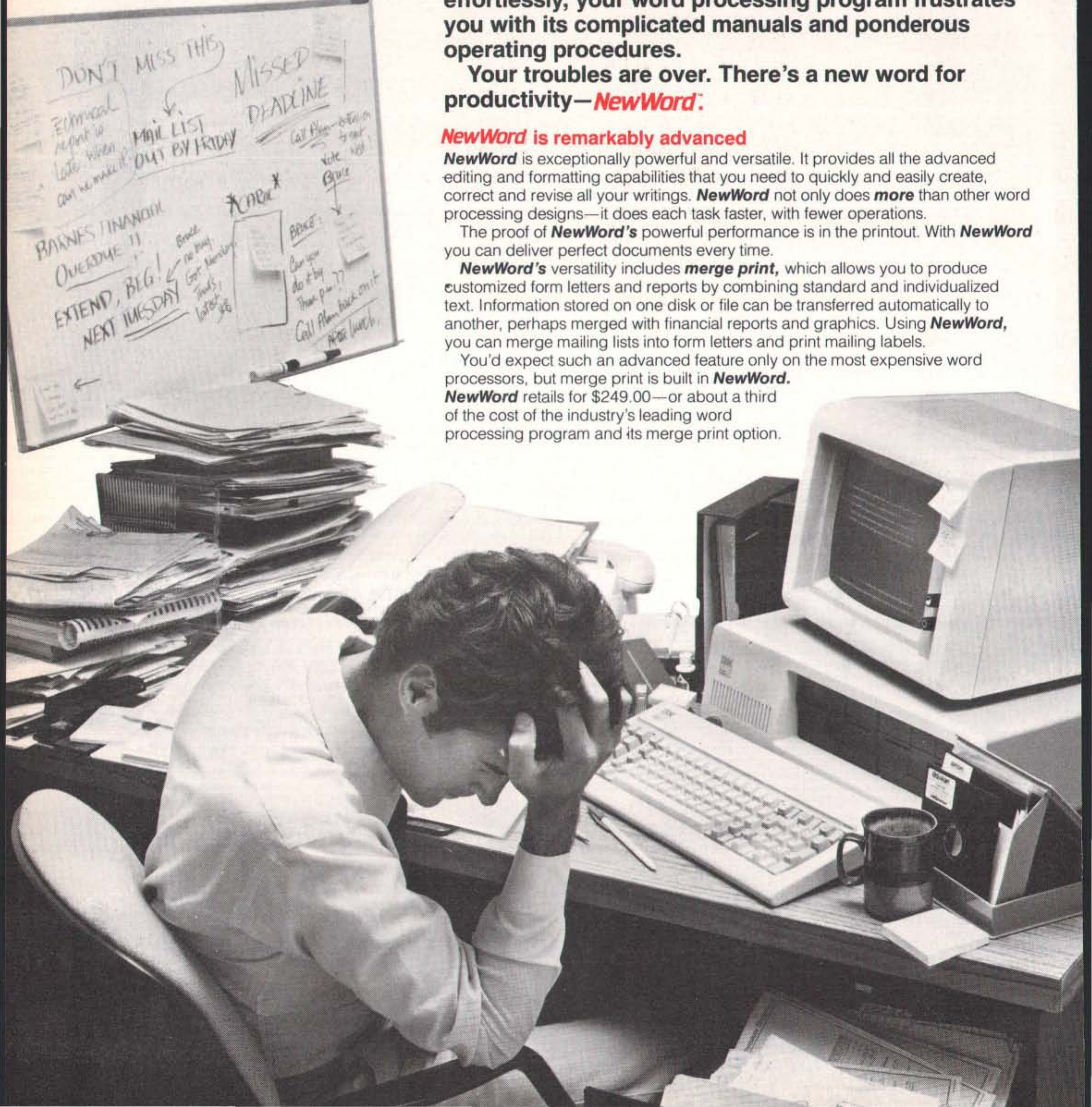

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Listing 1 continued:

```
blkfil  macro   x,y,w,h                 ; fills a rectangle w,h whose lower left
        mov     di,x                    ; corner is at x,y
        mov     bp,y
        mov     cx,w
        mov     bx,h
        video   4ah
        endm

putchr  macro   x,y,c                   ; puts a character at x,y
        mov     di,x
        mov     bp,y
        mov     al,c
        video   4bh
        endm

arc     macro   x,y,r,q                 ; Draws a quarter circle centered at x,y
        mov     di,x                    ; radius r, in quadrant q  2  1
        mov     bp,y                    ;                          3  4
        mov     bx,r
        mov     al,q
        video   4ch
        endm

circ    macro   x,y,r                   ; Circle at x,y radius r
        mov     di,x
        mov     bp,y
        mov     bx,r
        video   4dh
        endm

fill    macro   x,y                     ; Fill irregular shape where x,y is inside
        mov     di,x
        mov     bp,y
        video   4eh
        endm

wait    macro                           ; Wait for any key to be struck
        mov     ah.0
        int     16h
        endm

SSEG    SEGMENT STACK
        DW      32 DUP(?)
SSEG    ENDS

CSEG    SEGMENT
        ASSUME  CS:CSEG

MAIN    PROC    FAR
        PUSH    DS                      ; Save PC-DOS return information
        SUB     AX,AX
        PUSH    AX

; Setup
        gmode                           ; Enter graphics mode
        gpage   0                       ; Select the graphics page to write into
        disp    0                       ; Select the graphics page to be displayed
        clrscr                          ; Clear the page

; Fill entire screen to determine usable area
        fill    359,173
        wait                            ; Pause for measurement
        clrscr
```

Listing 1 continued on page 352

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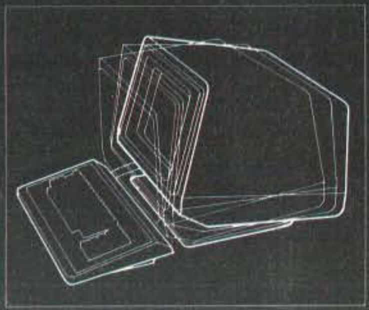
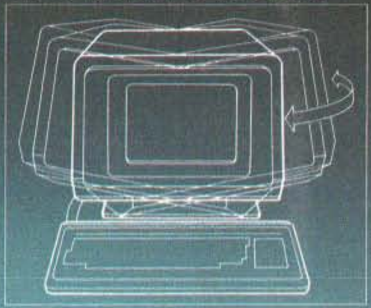

Tilt: 10° forward, 15° backward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Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Block Mode	YES	YES	NO	NO	YES
Insert/Delete Line	YES	YES	NO	NO	YES
Bi-Directional Aux Port	YES	YES	NO	YES	NO
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Answerback User Programmable	YES	NO	NO	OPT.	NO

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Circle 447 on inquiry card.

Listing 1 continued:

```
; Draw a circle
        circ    359,173,100
        wait                            ; Pause for a photo

; Fill it
        fill    359,173                 ; Fill the inside of the circle
        wait                            ; Pause for a photo

; Clear the screen and try something harder
        clrscr
        circ    359,173,100             ; Draw a circle like before
        circ    359,173,50              ; and then a smaller, concentric one
        wait                            ; Pause for a photo
        fill    270,173                 ; Pick point inside and try to fill the donut
        wait                            ; Pause for a photo

; Draw a square around the circle
        move    254,68                  ; Set the starting point
        dline   464,68                  ; Draw a square 210 pixels on a side
        dline   464,278                 ; centered around the center of the circle
        dline   254,278
        dline   254,68
        wait                            ; Pause for a photo

; Set to XOR mode and fill the circle
        level   2                       ; Set the level to XOR-mode
        blkfil  254,278,210,210         ; Fill the square
        wait                            ; Pause for a photo

; Clear the screen and return to text mode
        clrscr
        tmode

        RET                             ; Return to PC-DOS
MAIN    ENDP
CSEG    ENDS

        END
```

Text continued from page 344:

adapter work under HBASIC, though, and the HBASIC documentation provides a "cookbook" method of converting color BASICA programs to run under HBASIC.

Many of the Hercules card's features cannot be used from interpretive HBASIC, however. Linkages enable a program written in compiled BASIC to use the full set of Graph X routines, and there are easy ways to use Graph X from assembly-language programs and other compiled languages such as Pascal.

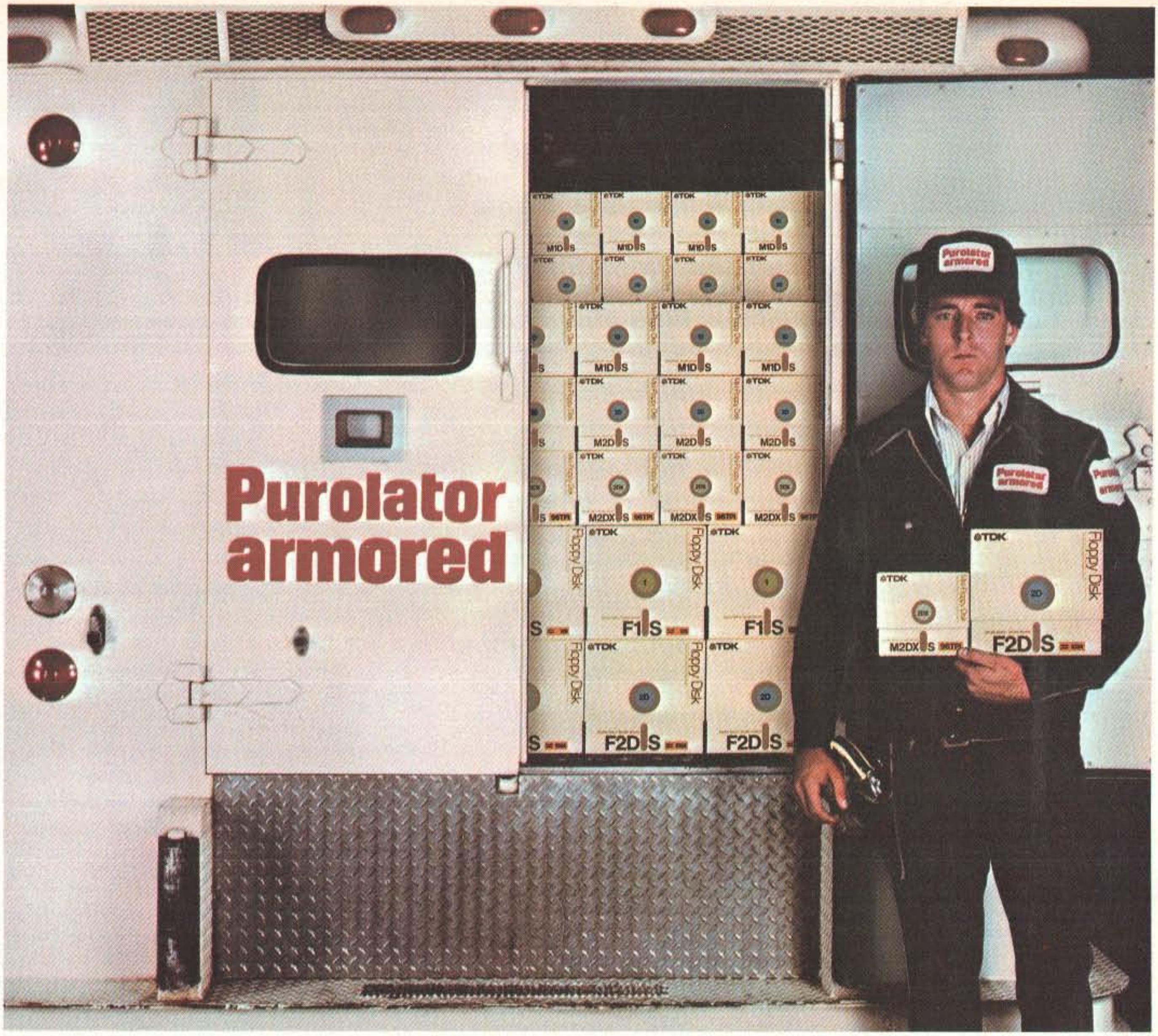
I found Graph X remarkably easy to use with the IBM assembler. Listing 1 is an IBM macro assembler program I wrote to generate some of the photographs in this article. The Graph X manual describes in detail the syntax for calling each function from assembly language, Pascal, and BASIC. My only complaint is that some of the examples are inconsistent. On page 13 of the Graph X manual is an example of drawing a circle (the comments on the right are mine).

```
MOV   AH, 4DH       Set the function to CIRCLE
                    (hexadecimal 4D)
MOV   DI, X         Set the x-location of the center
MOV   BP, Y         Set the y-location of the center
MOV   BX, RADIUS    Set the radius of the circle
INT   10H           Call Graph X to draw the
                    circle
```

Every example of individual functions uses a similar form, and the calling sequence is always the same: first, set the function code; second, initialize the registers; and finally, call Graph X.

However, when the time comes to give an example of an entire assembly-language program, the circle-drawing portion of that program is written as follows (the comments on the right are mine):

```
MOV   BX, 120       Set the radius
MOV   DI, 359       Set the x-location
MOV   BP, 173       Set the y-location
MOV   AH, 4DH       Select the CIRCLE function
INT   10H           Call Graph X to draw the
                    circle
```



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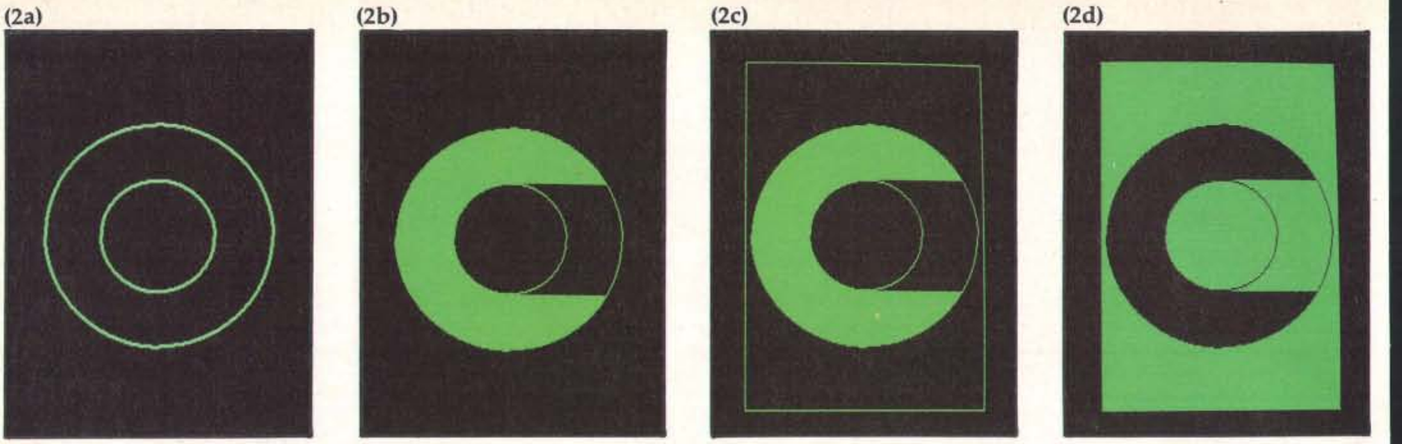


Photo 2: *The concentric circles in 2a were produced with the CIRCLE function. Then, in 2b, FILL (the convex-polygon fill function) was applied. Next, in 2c, the card's line-drawing function produced the rectangle framing the figure. In 2d, the rectangle was colored in with BLKFIL, set at an intensity level of 2 (the XOR function).*

Worse yet, the manual's only comment on those five lines of code was in the first line, simply "draw a circle." Consistency is very important in computer documentation, and I wish there were more in this set of manuals.

Despite the vagueness of the manuals, I experienced no difficulty producing a set of assembly-language and HBASIC programs to exercise the capabilities of the Hercules card. In the process, I found many usable features and three fairly important flaws. Most of the good features as well as the flaws are in the Graph X software and not in the Hercules board, so they can be corrected.

The manufacturer has provided two features, FILL and BLKFIL, that are indispensable in a graphics package. The first of these two features, an irregular-polygon fill (called a convex-polygon fill by the vendor), enables a programmer to select a point inside "an object with no interior holes and no peninsulas protruding into it." The interior of the polygon is filled by applying this function to the selected point, turning a hollow object into a solid one. Using FILL on an empty screen turns the entire screen green; using FILL on an object already filled erases the object entirely. Graph X performs this function with blinding speed. Photos 2a through 2d illustrate some of the capabilities of this software. The graphics were produced using the program in listing 1.

My only complaint about this feature concerns the definition of a convex polygon. There are plenty of algorithms to fill polygons with holes and peninsulas, and it's a shame that Hercules chose not to implement them. The vendor's convex-polygon fill can indeed be used to fill objects with holes, but those holes cast "shadows" that require more filling to repair them.

The other feature I especially like, BLKFIL, is used to fill rectangles in one of three ways. If the intensity value (set with the LEVEL primitive) is set at 0, the specified rectangle is erased. If intensity is set at 1, the rectangle is entirely filled in. If intensity is set at 2, the exclusive-OR (XOR) function alters the rectangle, as shown in photo 2d. I heartily approve of this feature. XOR is a useful graphics tool for preserving information; for example, it enables you to move a cursor nondestructively over a display.

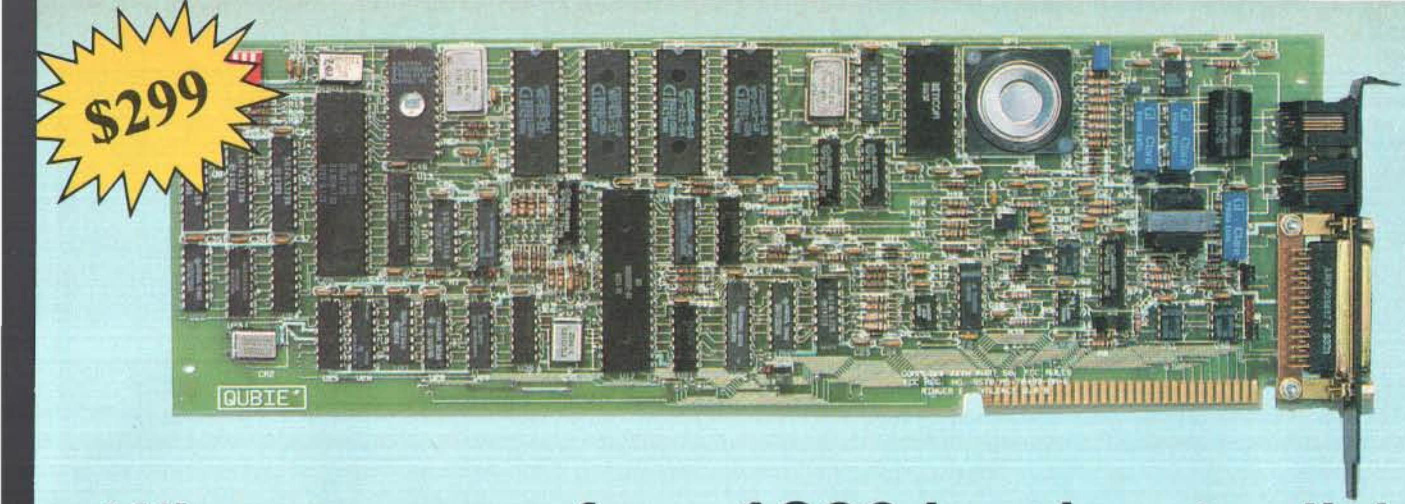
However, BLKFIL is as slow as molasses. I am willing, though unhappy, to accept this slow speed when using the XOR function but not when using BLKFIL ON (1) and BLKFILL OFF (0). No significant computation should be going on during those functions.

Another slight annoyance involves the aspect ratio, the ratio between the usable number of vertical and horizontal dots per inch. This ratio is important when you are trying to produce circles, for instance. The Hercules card provides an aspect ratio of 61/88, a rather unusual number that I expect resulted from trying to squeeze as many lines as possible onto the screen image. As the user's manual points out, this number can be approximated by 2/3, but a circle produced with an aspect ratio of 61/88 is measurably different from one produced with a ratio of 2/3. Nevertheless, most computers multiply by 61/88 as well as they do by 2/3 or 3/4. If you are working in a language such as FORTH, which is inherently integer-based, you may find this discrepancy frustrating. Listing 2, an HBASIC program that generates circles of various aspect ratios, was used to produce photo 3.

Hardware

I can offer very little criticism of the actual Hercules board because, with the exception of the occasional problem on power-up, it performs exactly as advertised. During switches between text and graphics modes, the screen gives a very distressing vertical *bounce,* which is harmless but potentially surprising the first time you see it. The switch between the two graphics pages, however, is as clean and glitch-free as you could possibly want.

A look at the documentation provided on the hardware reveals that an ambitious programmer could do many interesting things with the Hercules card. Mouse Systems has written a version of RasterOp that uses the Hercules; except for a brief demonstration at the 1983 West Coast Computer Faire, I haven't looked at it in detail. What I saw was very impressive, however.



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You can imagine how precise the components had to be to convert tones over a phone line into characters. Precision equates to cost. With the advent of the mass market in personal computers the economics of scale drove the costs of manufacture down but did not effect the precision required. The technology used is called "analog filtering". It is the process of sending (modulating) and receiving (demodulating) tones with perfect pitch. A lot of adjusting, noise suppression, and a little magic is required. Real expensive. Some use lots of chips and filters (known as discrete components). The latest stage is LSI (Large Scale Integration) technology. Which is the same old analog stuff condensed onto fewer chips.

A NEW IDEA

We took a different approach. With the Qubie' PC modem card you can say goodbye to the fellow who delivers your ice because refrigeration has been invented. Through the use of four microprocessors (see picture) the tones are chopped up **digitally** and measured millions of times per second, eliminating the need for analog circuitry. Two microprocessors do the modulating, two the demodulating. The chips are programmed to emulate the 103 (30 characters per second) or 212 (210 characters per second) standards and determine the correct speed automatically. It's a proven technology that provides outstanding performance. Best of all, it's inexpensive and reliable.

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We included every feature you would want in a modem card. It plugs into your IBM PC or XT and occupies any one slot since it is just 6/10 of an inch thick. This card comes with its own asynchronous port. If you would like to use the async port for another peripheral when your modem is not in use, we will add a connector for just $20. It's FCC registered for direct connection to your modular phone jack with the cable which is included. There is a separate jack for your telephone or you can listen through the board's speaker. It operates in full or half duplex mode on Rotary dial lines (pulse dialing) or on tone lines (DTMF), or a combination of both. It will work in originate or auto-answer modes. A separate microprocessor, a Z8, controls all the functions.

LET'S TALK SOFTWARE

Our modem is 100% compatible with the Hayes software commands so you can use any of the popular communications packages like Cross-Talk, Transend, or PC Modem. We go one better than the competition. We **include** one of these popular programs with your modem, PC-TALK III. **PC WORLD** magazine referred to it as "the benchmark that other PC communications packages are measured against." It stores phone numbers, log-on information, handles setting the modems characteristics, saves to disk files, transmits from disk files, even binary files. And to make sure data is sent and received accurately, there is the XMODEM protocol which detects errors caused by poor line quality and retransmits the data.

WHY BUY FROM US

Because besides having the most advanced product on the market, we stand behind it and you. If at any time during the one year warranty period your modem should require service, we will fix or replace it within 48 hours. Notice also there are no hidden charges in our price. Nothing extra for credit cards or COD charges. We even pay UPS to deliver to you. If you still are not convinced, and are ready to buy another brand of modem, ask them if their product can take our acid test.

THE ACID TEST

Qubie' gives you a 30 day satisfaction guarantee on your modem. If you are not completely satisfied we will refund the entire amount of your purchase including the postage to return it. If you can, get any of our competitors to give you the same guarantee. Buy any modem you like and return the one you don't like. We know which one you will keep.

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We don't have a clue. It's all here. A high quality, full featured, communications package at a price that used to be reserved for 300 baud modems. But if you decide to spend an extra $200 or $300, we would sure like to hear why. We have spent lots of time thinking about it, and frankly, we just can't come up with a reason.

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—Specify single or double sided disk drive

VISA master charge

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PRICE:

$299 includes 300/1200 Baud Direct-Connect modem card, PC-TALK III Software, cable to connect to modular phone jack, installation instructions and manual. 1 year limited warranty.

External async port connector	$20
Cable for Serial port to printer	$25

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Circle 361 on inquiry card.

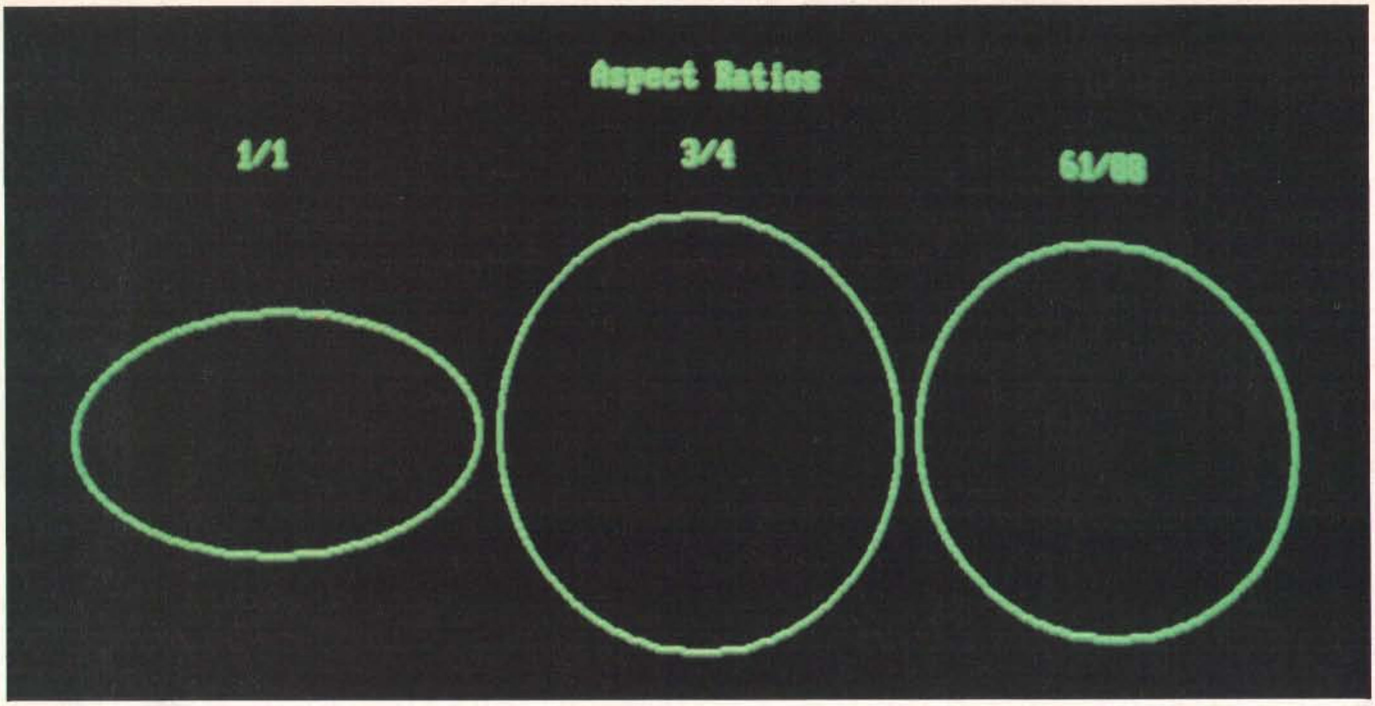


Photo 3: *A comparison of aspect ratios generated with the program in listing 1.*

Listing 2: *This HBASIC program generates circles of various aspect ratios. It was used to produce photo 3.*

```
10 REM ASPECT.BAS -- Demonstrates how an aspect ratio can affect a circle
15 REM Written by Tom Wadlow
20 CLS
30 CIRCLE(150,173),100
40 CIRCLE(360,173).100,,,,3/4
50 CIRCLE(570,173),100,,,,61/88
60 LOCATE 4,35:PRINT "Aspect Ratios";
70 LOCATE 6,15:PRINT "1/1";
80 LOCATE 6,40:PRINT "3/4";
90 LOCATE 6,62:PRINT "61/88";
100 LOCATE 21,15:PRINT "See the difference that 5/88 can make in a circle";
110 LOCATE 22,15:PRINT "The circle on the left (61/88) is correctly round"
120 REM Pause for a photo
130 LOCATE 1,1
140 INPUT " ",A$
```

The printer port on the graphics card has worked flawlessly with my Microprism 480. Hercules includes software that provides a graphics screen dump to the printer, but it works only with Epson printers equipped with Graftrax chips. Because I don't have an Epson, I couldn't test that feature. The screen dump works by replacing the built-in printer handler with a custom Hercules handler. You can do so by placing the commands INT10 and INT5E (for graphics and print handling, respectively) in your AUTOEXEC.BAT file to be executed on rebooting. Some packages, and specifically HBASIC, seem to replace the print handler themselves and thus are oblivious to preloading interrupt handlers.

Conclusion

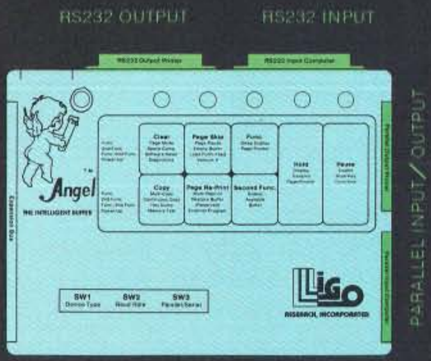
Despite the flaws in its documentation and software, the Hercules Graphics Card is a fine product. The hardware is well built and the architecture allows for much flexibility in constructing software. The Graph X package can provide users all the power they could want in terms of graphics primitives, and for those users whose tastes run in different directions, other companies are now coming out with more sophisticated software. In addition, some firms are modifying applications packages to use Hercules graphics. The Lotus 1-2-3 Information Manager is one such package. HBASIC is a good introduction to graphics, but people with sophisticated applications will probably want to work toward a compiled language in order to take full advantage of the Hercules Graphics Card.■

Thomas A. Wadlow (POB 2755, Livermore, CA 94550) received a B.S.E.E. degree from Carnegie-Mellon University. He works as an engineer at the Lawrence Livermore National Laboratory.

Circle 264 on inquiry card. ⟶

Let the *ANGEL* do the waiting . . . . . .

It has been said that 30% of microcomputer users will eventually purchase a buffer. For business users, a buffer pays for itself in the time and money it saves the user not waiting for the printout. The more you use your printer the more you need a buffer.



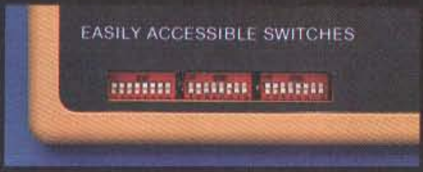
ANGEL HAS ALL INTERFACES

ANGEL, The Intelligent Buffer is the perfect mate for your system. It has both RS232 Serial and Centronics Parallel interface, and can convert from serial to parallel and parallel to serial. It is truly a universal buffer that is compatible with most microcomputer systems. This versatility means when you upgrade your system you can use the same ANGEL.

ANGEL passes data to the printer exactly as received from the computer and is independent of software — including graphics. The ANGEL also features an innovative page mode which carefully monitors the page break data during printing. Under the page mode you can reprint the last page, jammed pages, do page skip as well as page pause for single-sheet feeding.

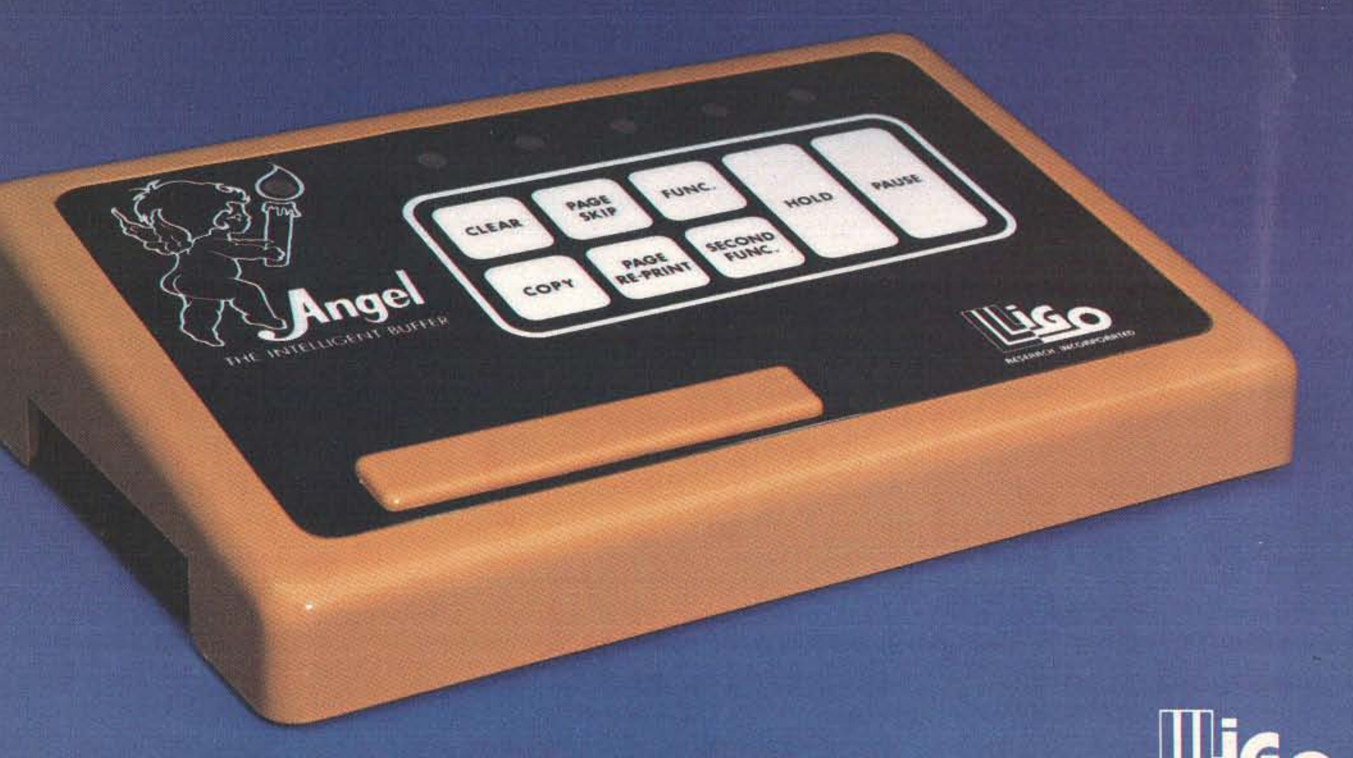
ANGEL is an intelligent buffer with 12 additional functions that may be activated when you need them; pause, hold, copy, clear, self-test, page reprint, page skip, page pause, multi-copy, continuous copy, space compression, hex dump, etc.

ANGEL comes with 64K bytes of memory, ample for most applications. Additionally, you may activate the space compression mode which in may cases extends the buffer capacity to more than 128K.



ANGEL is designed for all types of users – even those without technical background. All switches, including baud rate selection and parallel / serial configurations are externally accessible. Installation is a matter of connecting cables, setting up DIP switches and power-on. Ligo Research makes available standard cables/adaptors for most popular computer/printers. Connection diagrams are also provided for users who want to make their own cables.

With such a good product available now, why wait for your printer to catch up? You can order the ANGEL from your dealer or call direct to 1-800-323-3304, TODAY!



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IBM Announces the PCjr

by Rich Malloy

After months of speculation and seemingly random rumors, the Entry Systems Division of IBM announced its most basic entry system, a home computer called the PCjr. The long-awaited "Peanut" features an 8088 microprocessor, a "detached" keyboard (linked via infrared light), two game cartridge slots, and compatibility with the IBM PC.

Two configurations will be offered. The basic or entry configuration has 64K bytes of RAM (expandable to 128K bytes), color graphics capability, internal slots for a single-disk drive and modem, and external connections for several peripherals, including a joystick, a light pen, serial devices, a parallel printer adapter, and an RGB (red, green, blue) display. The price of the base system is $669.

In addition to the above, an enhanced system features 128K bytes of RAM (random-access read/write memory), a 5¼-inch, 360K-byte double-sided floppy-disk drive, enhanced graphics capability, and the ability to run many IBM PC programs. This configuration will cost $1269.

Demonstrator units should be on display at authorized dealers during December, but deliveries are not scheduled to begin until sometime in the first quarter of 1984.

Perhaps the PCjr's most important feature is its compatibility with its bigger brother, the PC. The enhanced version of the PCjr uses a new version of PC-DOS, called version 2.1, which is available for $65. This new version of PC-DOS is compatible with previous versions of PC-DOS, and thus many programs for the larger PC can run on the PCjr. However, this new version of PC-DOS apparently occupies a sizable amount of memory and thus limits the amount available to application programs. Many IBM PC programs will not have enough memory available to run. Among the programs that do run are Easywriter (version 1.15), pfs:File (1.05), Multiplan (1.1), Visicalc (1.2), and IBM Logo. Peachtext runs but is not recommended.

The main circuit board of the PCjr has 72 chips, including an 8088 with the same clock speed (4.77 MHz) as that of the PC. Circuitry for the color graphics display, the serial interface, and the joystick ports is all on the main board, along with ROM chips and 64K bytes of RAM. Three expansion slots are available: one for a second bank of 64K bytes of RAM ($140), one for a half-height disk drive ($480), and one for a 300-bps (bits per second) internal modem ($199). The slots are not interchangeable. An expansion bus connector is located on the right side of the machine. This is used to connect to a parallel printer adapter ($99), which attaches to the side of the machine. The power supply is housed in a separate enclosure. There is no socket, by the way, for an 8087 arithmetic processor.

The detached keyboard has 62 keys as opposed to the IBM PC's 83 keys. A diamond-shaped cursor-key arrangement is present, but no numeric keypad or function keys are included. Instead, a function Shift key is available that transforms the numeric keys into function keys. The left Shift key and the Return key are in their normal, pre-PC places. The spacing of the keys seems somewhat different than that of a standard Selectric typewriter, however. A touch-typist's fingers will have a tendency to fall off the keys into the large spaces between them.

The most interesting thing about the keyboard is its infrared connection. The keyboard has its own power supply (four AA batteries) and can communicate with the system unit as long as it is within 20 feet of it and in a direct line of sight of the computer's infrared detector. An optional keyboard cable is available for situations in which more than one system is in a given room.

The entry system features the same graphics capability as that of the IBM PC Color Graphics Adapter. The enhanced system, however, has extra memory that enables it to display more colors—for example, four colors in high-resolution mode (640 by 200 pixels). In addition, these four colors can be chosen from a palette of 16.

A number of peripherals and software packages were announced for the PCjr. These included joysticks ($40) and a thermal printer ($175). New software includes a cartridge-based version of BASIC that can access disk files and can use the enhanced graphics and sound capabilities of the PCjr. Other cartridge programs include several games (such as Crossfire) and educational programs. The game cartridges will sell for approximately $35.

It is also interesting to note the similarity of the PCjr to the initial introduction of the PC. The first PC had a relatively limited memory (256K bytes maximum), limited storage capability (160K bytes per disk), and, of course, that controversial keyboard. In fact, rumors even circulated that these limitations were designed to limit competition with IBM's more expensive Display Writer and Data Master. Similarly, the PCjr has comparatively limited memory (128K bytes), limited storage (one disk drive), and yet another new keyboard. The PCjr will probably be a very strong contender in the home computer market. But these limitations will surely limit its competition with the PC—for the time being, anyway.■

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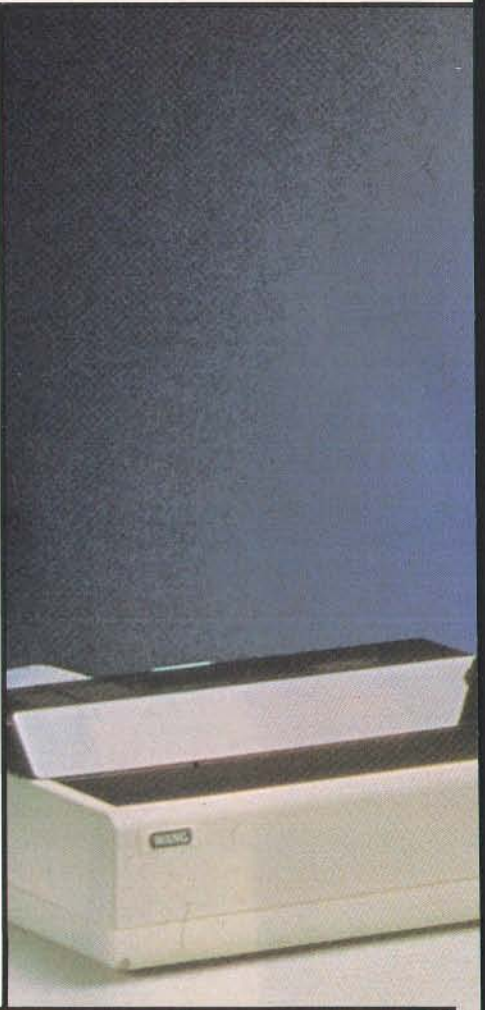
Hardware Review

The Wang Professional Computer

Providing an easy-to-use word-processing program with sophisticated features, this 16-bit microcomputer runs MS-DOS 2.0

by Elaine Long



A year ago, Wang Laboratories entered the rapidly growing microcomputer arena with the Wang Professional Computer. The physical features of this 16-bit system are, to use a current industry buzzword, ergonomic—flexibly designed to suit limited space, neutral in color, and pleasant and easy to use.

The basic system, based on the Intel 8086 processor, provides an 8-MHz cycle speed, 128K bytes of memory (expandable to 640K bytes), a Centronics parallel-printer interface port, an RS-232C asynchronous serial interface, five expansion slots, a BASIC interpreter, built-in diagnostics, and 4-channel DMA (direct memory access) capability.

The Display

The separate monitor (see photo 1) has a pedestal base that allows you to vary the angle of the 12-inch, green-on-black, 25-line by 80-character (800 by 300 pixel) video display. An optional arm and desk clamp for the monitor provide even greater flexibility, allowing you to swing the monitor away from your working area when you don't need it. Characters are formed on an 8- by 10-pixel matrix, using the 96-character ASCII (American National Standard Code for Information Interchange) character set plus 128 additional foreign and graphics characters.

Character display attributes include boldface, inverse video, blinking, boldface underscore, reverse boldface underscore, subscript, and superscript.

The System's Keyboard

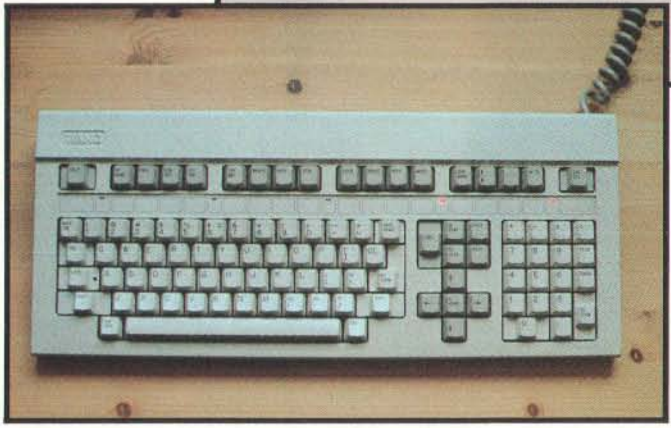


Photo 2: *The Wang's sculptured keyboard contains 101 sculptured keys, including 16 programmable function keys. Note the indicator lights, which can signal problems even when the display is not working.*

The detached keyboard pictured in photo 2 consists of 101 sculptured keys arranged in groupings with similar functions. These groupings include a standard typewriter keypad, a 15-key numeric keypad, function keys for advanced operation and editing, 16 programmable special-function keys (used by Wang-supplied application programs and third-party and user-developed programs), 5 cursor-control keys, and a Help key. Knobs on the front of the monitor control display brightness. The Wang PC's display, which has an 800- by 300-pixel resolu-

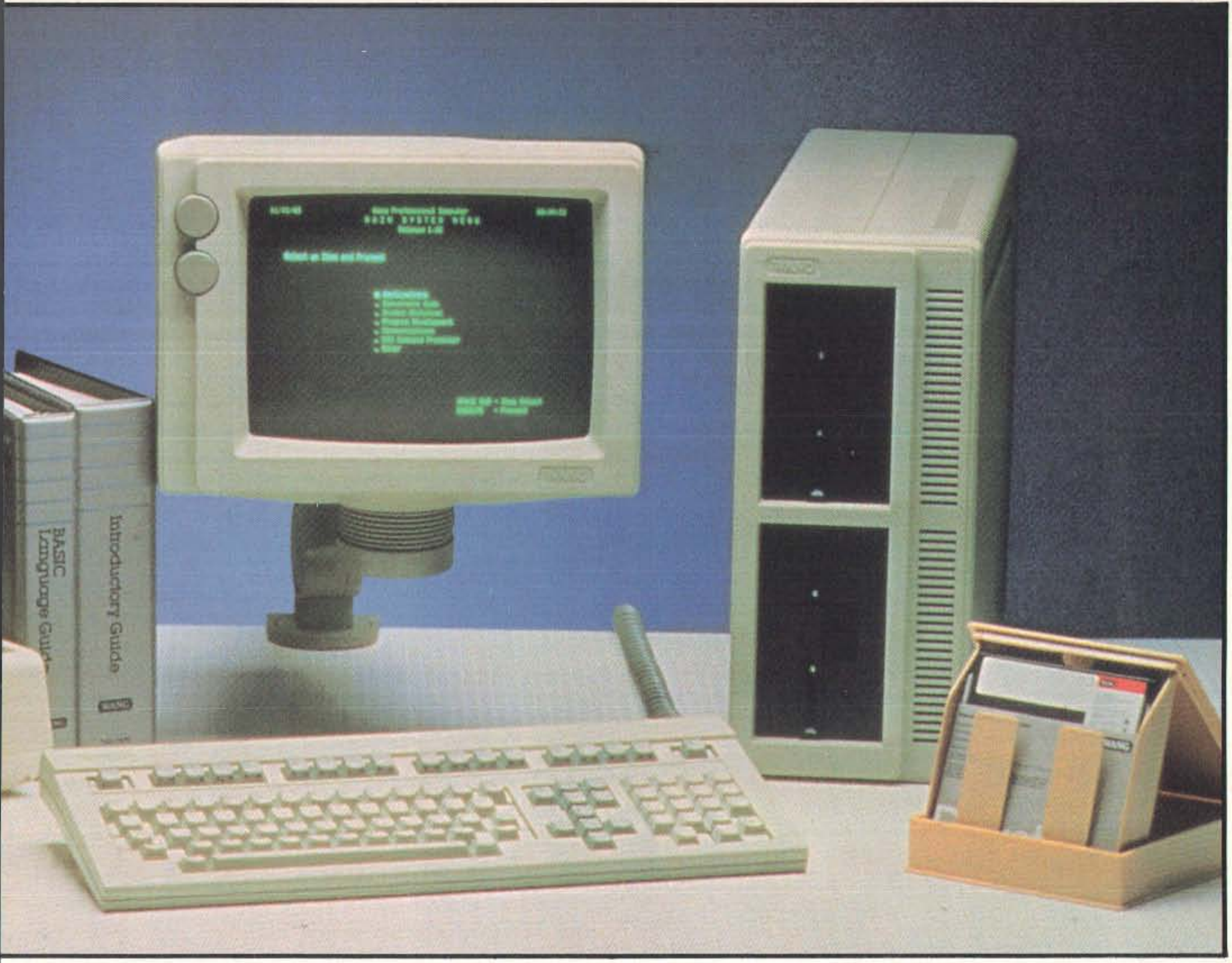


Photo 1: *In this configuration, the Wang Professional Computer rests on an optional stand (the PC Arm, $150). A daisy-wheel printer (Model PC-PM010, approximately $600) is on the left. Interestingly, the system unit, which houses two floppy-disk drives, can be placed either horizontally or vertically on a desk or it can be clamped to the side of a desk with the PC Clamp (which comes with the PC Arm).*

tion, seems somewhat sharper than that of the IBM PC's monochrome monitor, which has a 720- by 350-pixel resolution. A bit-mapping scheme handles graphics. Five programmable LED (light-emitting diode) indicators on the keyboard are programmed to operate during power-on diagnostics, which takes about 30 seconds, indicating the beginning, end, and results of diagnostic tests at the start of each operation. All keyboard data is buffered; the 8086 processor is interrupted less than once every 10 milliseconds (ms). The keyboard also houses a 2-inch speaker for sound generation and thus provides audio and tactile feedback.

Two types of reaction are common to the audio-feedback feature of the Wang PC: some users love it, and others can't stand it. I found its very loud sound annoying. The feature is programmable, though, so you can reprogram the speaker to modify its volume and tone.

Disk Drives

A basic system comes with a 5¼-inch double-sided double-density floppy-disk drive, which records 48 tracks per inch and can store 360K bytes of data. Although a great deal of software is written in a single-sided double-density format, it can still be used on the Wang PC because the computer's operating system, Microsoft's MS-DOS 2.0, enables it to also read single-sided double-density disks. You can also add a second disk drive or a 5¼-inch, 10-megabyte Winchester disk and controller. A system-diagnostics software disk comes as standard equipment.

Operating-System Features

Microsoft's MS-DOS has received much attention recently, not only because IBM chose it for its Personal Computer, but also because the test of time is revealing that this operating system stands up to the development needs of 16-bit applications. It is therefore safe to say that MS-DOS is emerging as a standard operating system. Wang enhanced MS-DOS for use on its computer.

Examples of utilities that Wang added to the operat-

At a Glance

Name
Wang Professional Computer

Manufacturer
Wang Laboratories Inc.
1 Industrial Ave.
Lowell, MA 01851
(617) 459-5000

Dimensions
Processor unit: 23.1 by 14.9 by 6.5 inches; 27.8 pounds
Video display: 11.8 by 13 by 10.8 inches; 14 pounds; angle of tilt with pedestal base: 15° back and 5° forward
Keyboard: 11.8 by 13 by 10.8 inches; 14 pounds; connected to the rear of the electronics unit by a telephone-cord-like coil

Computer
Intel 8086 16-bit microprocessor (8087 coprocessor is optional), 8-MHz system clock, 128K bytes of memory minimum and 640K bytes maximum; five expansion slots support memory enhancements and options; interfaces for disk control and video terminal control board are available; Centronics parallel port and RS-232C serial port come standard

Keyboard and Monitor
101-key detached keyboard with numeric keypad and 16 programmable special-function keys, including Help, Cancel, and Delete keys; 12-inch phosphor green-on-black display with 800- by 300-pixel resolution and 80-character by 24-line display format; 8- by 10-pixel/cell character display, 224-character set; tilt-and-swivel mount

Disk Storage
Provisions for removable- and fixed-disk storage housed in system; 5¼-inch double-sided double-density floppy disk: 360K bytes of storage, 48 tracks per inch, 250K-byte/sec data-transfer rate; single-sided double-density disks also read; additional 10-megabyte hard disk or floppy disk accommodated by expansion cabinet

Operating System
MS-DOS 2.0 permits dynamic file-space allocation, random and sequential file access, and automatic start-up; Wang-enhanced user interface enables menu mode or MS-DOS command mode of operation and provides user prompts; features include menu interface for systems utilities for file management, conversion aids, screen-formatting utilities, file-to-document conversion utilities, and program-development tools with menu-driven editor and on-line debugger

Software
MS BASIC interpreter included; BASIC compiler: $295, MS Pascal: $295, MS FORTRAN: $354, MS COBOL: $695, Asynchronous Communications: $55, PC Word Processing: $500, Business Graphics: $300, Data Base: $650, 2780/3780: $200, Software Productivity Package (including Multiplan, Wang Word Processing, and Asynchronous Communications): $650; remote Wangnet for VS Communications, VS Workstation Emulation, OIS Workstation Emulation, and Alliance Workstation Emulation: price not available; PC Notebook: $200

Prices
Single floppy-disk system without monitor: $2595
Single floppy-disk system with monitor: $3265
Double floppy-disk system with monitor: $3790
10-megabyte hard-disk, single floppy-disk system: $5650

ing system include one for modification of communication parameters of the RS-232C serial port and utilities for text-to-document and document-to-text conversion. Others are Compare Data and Modify System Menu utilities. The operating system also supports four printer drivers: for the Wang PC-PM010 matrix printer, the NEC Spinwriter 3530, a general parallel printer, and a general serial printer.

In keeping with the goal of ease of use, the Wang PC, unlike the IBM PC, does not require users to learn the MS-DOS command structure. Instead, a user can perform all file functions on the Wang machine using standard English menu prompts. Photo 3 illustrates the operating-system utilities menu, and photo 4 shows an applications menu. The MS-DOS command-language mode is available, however, so that users familiar with that mode of operation can utilize it. Help screens are available to assist with nearly all selections within the operating system.

Word Processing

Wang Laboratories has set many standards for word processing, and the word-processing system designed for this computer approaches the same levels of sophistication and ease offered by the company's dedicated word processors. The Wang PC, however, is designed for use by people who have had no formal training in the use of data- or word-processing systems.

"It is our feeling," said a representative of Wang Laboratories, "that if the professional cannot learn to use the word-processing package within 30 minutes, he will never learn to use it." Through the extensive use of word-processing function keys and a hierarchical menu structure, Wang word-processing software has, to a large degree, achieved the company's goal and made the system simple to learn.

The word-processing screen is headed by a primary-status (or format) line that indicates the name of the document the operator is using as well as its page number and the line and location in the line where he is working (see photo 5). [**Editor's Note:** *Photos 5 and 6 show menus of version 1.0 of Wang's word-processing package. Version 2.0, discussed in this review, provides enhanced features.*] The format line controls the vertical line spacing, tab settings, and line length of all text following it. Along with standard single-, double-, and triple-spacing, you can format one-and-one-half-, half-, and quarter-spacing. Although the system can display only 80 characters across the screen, a horizontal-scroll feature lets you view and create documents with widths to 158 characters.

You can change the default format line fairly easily. You merely move the cursor to the home position, press the Format function key, make the necessary changes in the format mode, and then press the Execute key. The format line can be revised anywhere within a document, for such purposes as creating tables. The primary format, or any alternate format you have established, can then be recalled when needed.

Version 2.0 permits handling pagination either as you enter text by highlighting a suggested page break or at the end of the document's entry. For example, when text entry reaches line 55, enough text to fill a standard 8½- by 11-inch sheet of paper leaving adequate margins, the system sounds a tone and highlights the status line. You can then either enter a page break with the Page function key or continue text entry and set pagination when you're finished typing the document.

Using the function keys marked Previous and Next, you can scroll through a document screen by screen. When you move from one screen to the next, three lines of the previous screen's text appear at the top of the screen. A paging symbol signifies page separation. This logical method makes you aware of page breaks, although you are actually scrolling through screens rather than pages, and thus simulates the way you would page through a manuscript.

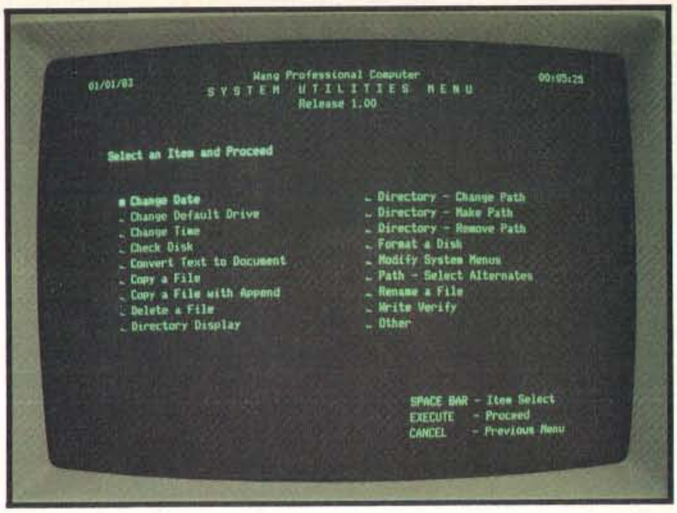
Global search and replace, a function incorporating both the search and the replace functions, requires that you position the cursor under the first character of the string you want to replace, hold down the Shift key, and press the Replace function key. While you move the cursor through the string you want replaced, its characters are highlighted. The screen then prompts, "Replace it?" and you have the option of performing an automatic global replace throughout the document or a selective replace.

I tested the speed of the automatic-replace function by entering a 200-word English-language document and copying it onto 10 screen pages, creating a 2000-word document. The last word on each page, the German word "Geschwindigkeit," I replaced with its English translation: speed. From the initial point of pushing the Shift and Replace keys to the replacement of the last occurrence of the word Geschwindigkeit, the procedure took 51 seconds. I then tested to see how quickly I could "page" through this same document. It took 32 seconds to scroll from page 1 to page 10.

The insert function is a bit unusual. When you press the Insert function key, all characters except the 29 immediately following the cursor disappear from the screen. Those 29 characters appear in the left-hand bottom of the screen while text is inserted. This movement may startle some first-time users, causing them to think that they've lost part of their text.

You can recall menus during text entry to select all the command functions and character attributes, including boldface, underscore, double underscore, subscript, and superscript. Photo 6 shows a menu displayed on a Wang PC monitor. You can use command functions and character-attribute automodes, however, without accessing those menus. The commands and automodes work well and are easy to use. Character attributes are displayed accurately on the screen, with boldface characters shown in reverse video.

The Wang word-processing program does not display right-hand justification, however, which might cause problems for some users. Instead, justification is handled



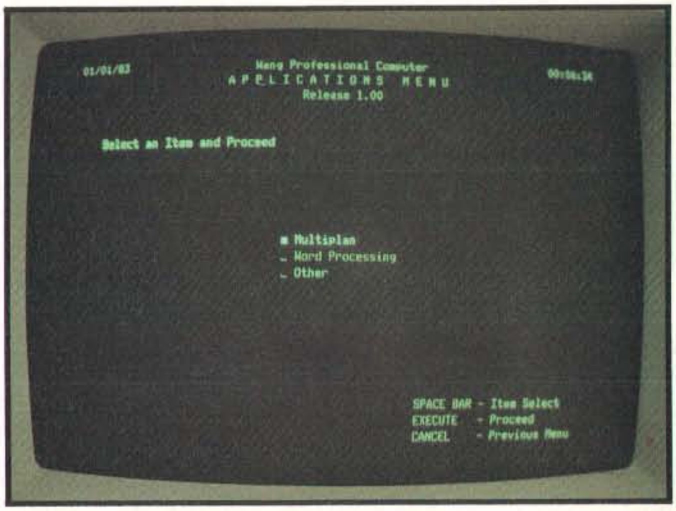
```
01/01/83               Wang Professional Computer               00:05:25
                  S Y S T E M   U T I L I T I E S   M E N U
                               Release 1.00

    Select an Item and Proceed

      ■ Change Date                      _ Directory - Change Path
      _ Change Default Drive             _ Directory - Make Path
      _ Change Time                      _ Directory - Remove Path
      _ Check Disk                       _ Format a Disk
      _ Convert Text to Document         _ Modify System Menus
      _ Copy a File                      _ Path - Select Alternates
      _ Copy a File with Append          _ Rename a File
      _ Delete a File                    _ Write Verify
      _ Directory Display                _ Other

                                              SPACE BAR - Item Select
                                              EXECUTE   - Proceed
                                              CANCEL    - Previous Menu
```

Photo 3: *The menu of utility programs included in Wang's version of the MS-DOS operating system.*



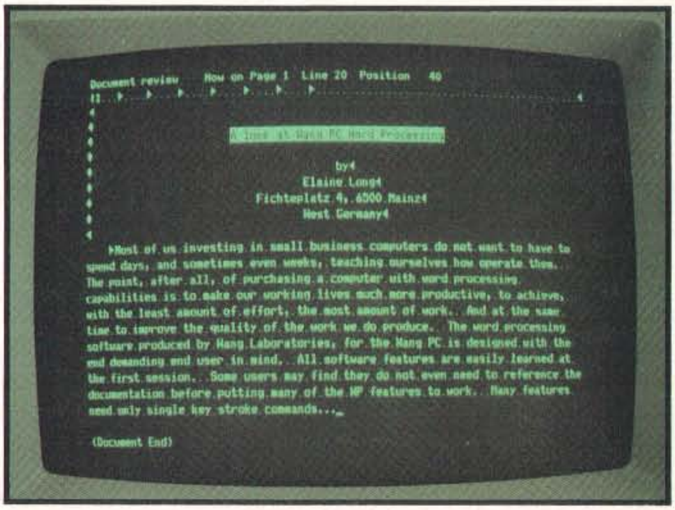
```
01/01/83               Wang Professional Computer               00:06:34
                     A P P L I C A T I O N S   M E N U
                               Release 1.00

    Select an Item and Proceed

                          ■ Multiplan
                          _ Word Processing
                          _ Other

                                              SPACE BAR - Item Select
                                              EXECUTE   - Proceed
                                              CANCEL    - Previous Menu
```

Photo 4: *A menu of application programs in Wang's version of MS-DOS.*



```
Document review    Now on Page 1  Line 20  Position   40

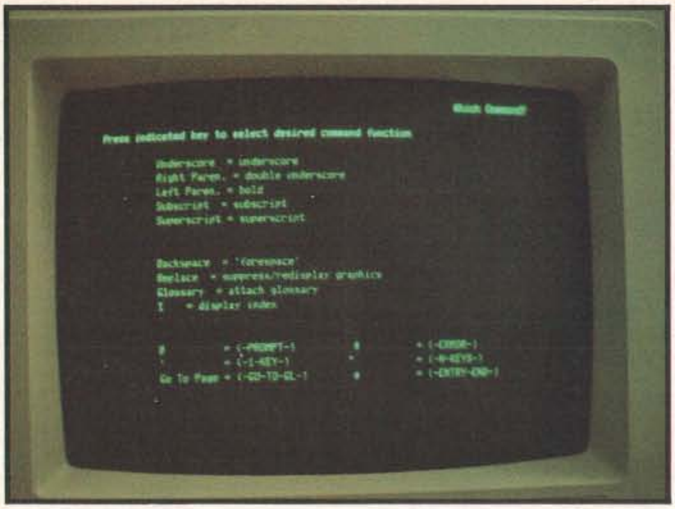
                   A look at Wang PC Word Processing

                                 by
                             Elaine Long
                      Fichteplatz 4, 6500 Mainz
                             West Germany

    Most of us investing in small business computers do not want to have to
spend days, and sometimes even weeks, teaching ourselves how operate them.
The point, after all, of purchasing a computer with word processing
capabilities is to make our working lives much more productive, to achieve,
with the least amount of effort, the most amount of work.  And at the same
time to improve the quality of the work we do produce.  The word processing
software produced by Wang Laboratories, for the Wang PC is designed with the
end demanding end user in mind.  All software features are easily learned at
the first session.  Some users may find they do not even need to reference the
documentation before putting many of the WP features to work.  Many features
need only single key stroke commands..._

(Document End)
```

Photo 5: *An example of text produced by Wang's word-processing program. The summary line and format line are at the top. Spaces are indicated with half-intensity periods.*



```
                                              Which Command?
Press indicated key to select desired command function

      Underscore  = underscore
      Right Paren. = double underscore
      Left Paren. = bold
      Subscript  = subscript
      Superscript = superscript

      Backspace  = 'forespace'
      Replace   = suppress/redisplay graphics
      Glossary  = attach glossary
      I    = display index

      #          = (-PROMPT-)        #          = (-ERROR-)
      '          = (-1-KEY-)         "          = (-N-KEYS-)
      Go To Page = (-GO-TO-GL-)      #          = (-ENTRY-END-)
```

Photo 6: *A menu of commands for Wang's word-processing program.*

during printing.

Another feature of the word-processing package, the glossary function, will be used extensively in offices by professionals who have much correspondence or prepare many documents. This function permits you to recall and insert, at any point in a document, an unlimited amount of standard text and editing formats. It is useful, for example, for often-used tables and forms. Learning how to use the glossary feature might take more time for a novice than learning any of the system's other word-processing features, but anyone who takes advantage of it will discover that preparing and using a glossary will help save time by eliminating much repetitive typing. The glossary is easily recalled with two keystrokes.

For copying and moving a string or block of text, four separate operations are available: copy, move, super copy, and super move. The copy and move functions affect text within one document and are handled with Copy and Move function keys. The super copy and super move functions, however, involve transfers between documents, which may be on the same disk or on different ones.

When you are finished with text entry or editing, you push Cancel, to which the screen responds "End of Edit?" If it is, you push Execute. Then a "rearranging" statement briefly appears on the screen, followed by the main word-processing menu. Executing the Print Document option brings you to the printing menu. After you've selected various printing options (number of originals, page length, margin setting, character set, pitch, justification, form type, and lines/inch) and pressed Execute, printing starts instantaneously.

Version 2.0 has a menu for document handling: copy doc., delete doc., and prepare new disk (format a disk). This menu is convenient to use and saves time, especially when the system is using only floppy disks. You do not have to go out of the word-processing program and back into the operating system to perform these operations.

Another feature of version 2.0 is a spelling checker with a 30,000-word dictionary that you can customize.

The software also performs an alphanumeric sort for a maximum of eight pages of 4000 characters each, sorting as many as four fields in one pass. Also available is a math function that performs multiplication, division, addition, and subtraction in columns and rows, providing totals, subtotals, grand totals, and verification of previously computed data. Because version 2.0 requires 128K bytes of memory, Wang Laboratories suggests that you start with 256K bytes of system memory.

Applications Software

Options include FORTRAN, Pascal, and COBOL compilers and a macroassembler. In addition, Multiplan, a financial planning and modeling package, has been licensed from Microsoft for use on the Wang PC. Also, Wang has recently released PC Notebook, a highly flexible database using an unstructured data format.

One of the first programs Wang Laboratories developed for the PC is communications software for asynchronous and synchronous communications, opening the way for Wang workstation emulations and remote Wangnet applications.

With the 3276 SNA/SDLC and 3270 BSC (Bisync) software packages, the Wang PC can function as a remote terminal, communicating with host mainframe computers and the IBM 3287 and 3284 printers. The packages permit the Wang PC to actively interact with many IBM mainframe systems, accessing host application programs or timesharing options, without changing the host application programs. Both of these emulation packages also support the IBM 3278 terminal keyboard.

Much third-party software is also available for the Wang PC. Peachtree Software Inc. has released a number of business packages. Among them are Inventory Management, Accounts Payable, Job Costing, Sales Invoicing, and Payroll programs. Available, too, is 1-2-3, a combination database, business graphics, and spreadsheet package from Lotus Development Corporation, as well as TK Solver, a mathematical-calculation package designed for financial planners, designers, and engineers. In the Software Connections program, Wang Laboratories has released an industry/applications-software cross-reference to aid in matching users' needs with available software.

This brings us to that big question of IBM PC/Wang PC software compatibility. Both systems use the same operating system, disk media, and microprocessor (the Wang PC uses the 8086; the IBM PC, the 8088). The contents, therefore, of any disks written by the IBM PC can be read by the Wang PC. And as long as an application program written for the IBM PC does not circumvent the I/O (input/output) facilities of the operating system, the Wang PC is fully compatible with the IBM PC.

But very rigorous market conditions have compelled some independent software companies to target applications software for use on a specific computer. Examples are those programs that were developed specifically for

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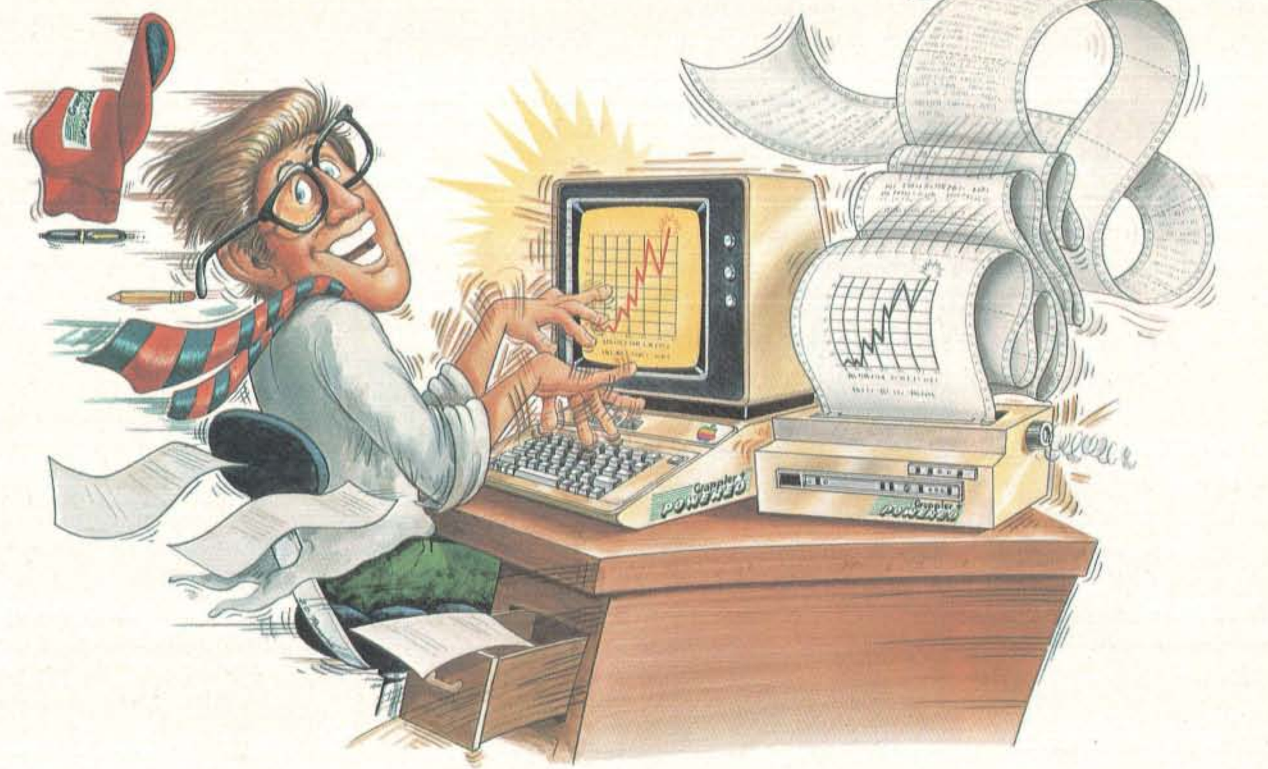

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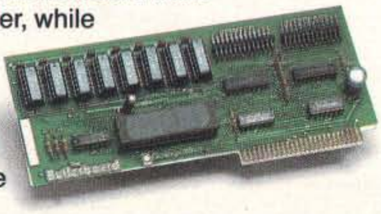

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use on the IBM PC, taking advantage of machine-dependent capabilities. Techniques used in developing a machine-dependent software package include bypassing the operating system's I/O capabilities, the use of keyboard-specific function keys and display-specific attributes, and the use of machine-specific subroutines in the BIOS (basic input/output system), ROM (read-only memory), or PC-DOS. Therefore, not *all* application packages developed for the IBM PC will operate on the Wang PC without modification. But because the Wang PC and the IBM PC use the same type of operating system, microprocessor, and disk media, machine-dependent packages can be easily modified through the software source code. For those programs that do not operate on the Wang PC, Wang Laboratories suggests that you request the software's vendor to modify them, because source code is generally not available to customers. And since Wang released the technical reference manual for the Wang PC, it has become a simple matter for a software developer to make such modifications.

The documentation supplied with the Wang PC does not talk down to readers to the point of insulting them.

System Expansion

The basic unit has five expansion slots. RAM (random-access read/write memory) is expandable to 640K bytes. If you install a CP/M emulation card, which has a Z80 microprocessor, the system can use applications software written for the CP/M-80 operating system. Two types of video cards can be used: the Wang monitor card (for Wang's monochrome monitor) or an industry-standard graphics card that supports any RGB (red-green-blue) monitor or NTSC (National Television System Committee) black-and-white or color television. The unit can house a 5¼-inch, 10-megabyte Winchester disk drive with controller card. The basic system also includes an industry-standard parallel port for connecting a printer and an RS-232C asynchronous serial port for terminal emulation and remote or internal communications.

When you use the Wang PC with the 3276 SNA/SDLC and 3[illegible]0 BSC emulation software, you will need a multiport communications card, a modem cable, and an RS-232C/CCITT V.24 modem.

The system software sends the eighth bit of each byte to the printer to take advantage of the international character set and dot-addressable printers for graphics capabilities. Because it sends the eighth bit, however, it is not fully operable with all printers on the market. The four printer drivers within the operating system solve that problem to a large degree. The two general printer drivers, however, do not support *all* possible printer functions. I have been using the Epson FX-80 matrix printer, which, with the one exception of the double-underscore function, fully supports the system's word-processing software. I would think, though, that manufacturers are rushing to make their printers compatible with as many systems as possible. Therefore, many other compatible printers are probably available now.

Documentation

The documentation supplied with the Wang PC does not suffer from the problems that much of the documentation written over the past few years experienced. It is not weighed down by an overabundance of user-friendliness, nor does it talk down to readers to the point of insulting them. Instead, *The Introductory Guide* is thorough and logically organized. It may, in fact, prove too thorough for some users. The manual is, however, written for everyone, covering the spectrum of required information from such basic material as how to insert a floppy disk to batch processing in the DOS command processor. As in all the documentation provided, illustrations, a table of contents, appendixes, and an index are supplied.

The BASIC Language Guide, provided with the system, is a straightforward manual designed for use by programmers familiar with standard BASIC programming. For the user who has the time, *The Word Processing Training Guide* covers all of the word-processing package's features. I found that an efficient way to quickly learn to use the package is to instead go through the *WP Reference Guide.* All of the system documentation comes in loose-leaf binders, making the insertion of updates and user notes convenient.

Prices

The basic Wang Professional Computer, Model PC 001, provides 128K bytes of memory, a 5¼-inch floppy-disk drive with 360K bytes of storage, the MS-DOS operating system, Interpretive BASIC, and a keyboard. It costs $2595.

The Wang PC 002 includes those features plus a monochrome monitor and controller for $3265. Adding a second drive to the PC 002 configuration produces the PC 003. This costs $3790, comparing favorably with a similarly equipped IBM PC, which sells for $3800.

These prices include diagnostics software and documentation but not applications software. For $650, Wang sells a Software Productivity Package, which includes Multiplan, Wang Word Processing, and asynchronous-communications software. Wang also sells programming-language interpreters and compilers as well as many applications-software packages. A CP/M card costs $600, and a 10-megabyte Winchester disk drive with a controller sells for $2385.

Summary and Conclusions

The Wang PC system, based on 128K bytes of RAM, the 16-bit 8086 microprocessor, and MS-DOS 2.0, a 16-bit operating system, was designed to meet the rapidly growing hardware demands of a new generation of soft-

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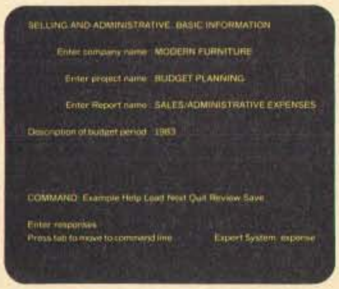


```
SELLING AND ADMINISTRATIVE  BASIC INFORMATION

        Enter company name  MODERN FURNITURE

         Enter project name  BUDGET PLANNING

         Enter Report name  SALES/ADMINISTRATIVE EXPENSES

Description of budget period  1983

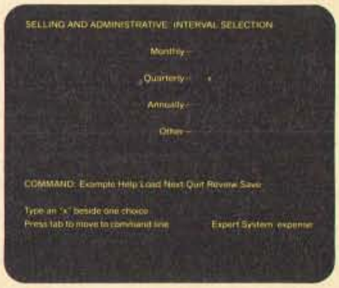


COMMAND  Example Help Load Next Quit Review Save

Enter responses
Press tab to move to command line           Expert System  expense
```

Gentlemen, start your computers.

Time: 0



```
SELLING AND ADMINISTRATIVE  INTERVAL SELECTION

                        Monthly -

                      Quarterly -    x

                       Annually -

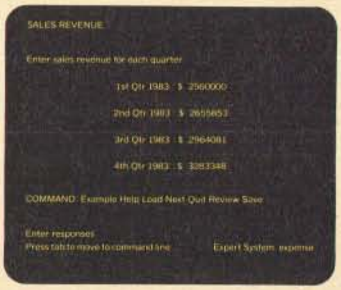
                          Other -


COMMAND: Example Help Load Next Quit Review Save

Type an "x" beside one choice
Press tab to move to command line           Expert System  expense
```

Select budget intervals.

Time: 0.5



```
SALES REVENUE

Enter sales revenue for each quarter

                 1st Qtr 1983 : $ 2560000

                2nd Qtr 1983 : $ 2655853

                 3rd Qtr 1983 : $ 2964081

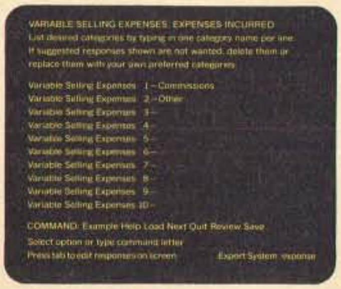
                 4th Qtr 1983 : $ 3283348

COMMAND: Example Help Load Next Quit Review Save

Enter responses
Press tab to move to command line           Expert System  expense
```

Enter sales revenue.

Time: 1.0



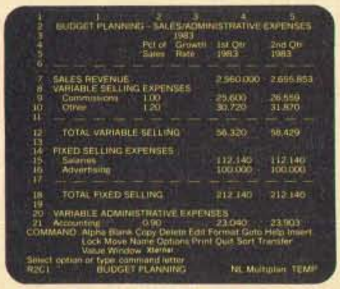
```
VARIABLE SELLING EXPENSES  EXPENSES INCURRED
List desired categories by typing in one category name per line.
If suggested responses shown are not wanted, delete them or
replace them with your own preferred categories

Variable Selling Expenses  1 -Commissions
Variable Selling Expenses  2 -Other
Variable Selling Expenses  3 -
Variable Selling Expenses  4 -
Variable Selling Expenses  5 -
Variable Selling Expenses  6 -
Variable Selling Expenses  7 -
Variable Selling Expenses  8 -
Variable Selling Expenses  9 -
Variable Selling Expenses 10 -

COMMAND: Example Help Load Next Quit Review Save
Select option or type command letter
Press tab to edit responses on screen        Expert System  expense
```

Enter selling expenses.

Time: 1.5



```
 1        1            2      3         4          5
 2   BUDGET PLANNING - SALES/ADMINISTRATIVE EXPENSES
 3                           1983
 4                    Pct of  Growth  1st Qtr    2nd Qtr
 5                    Sales   Rate    1983       1983
 6   - - - - - - - - - - - - - - - - - - - - - - - - - -
 7   SALES REVENUE                    2,560,000  2,655,853
 8   VARIABLE SELLING EXPENSES
 9     Commissions    1.00             25,600     26,559
10     Other          1.20             30,720     31,870
11   - - - - - - - - - - - - - - - - - - - - - - - - - -
12     TOTAL VARIABLE SELLING          56,320     58,429
13
14   FIXED SELLING EXPENSES
15     Salaries                       112,140    112,140
16     Advertising                    100,000    100,000
17   - - - - - - - - - - - - - - - - - - - - - - - - - -
18     TOTAL FIXED SELLING            212,140    212,140
19
20   VARIABLE ADMINISTRATIVE EXPENSES
21     Accounting          0.90        23,040     23,903
COMMAND: Alpha Blank Copy Delete Edit Format Goto Help Insert
           Lock Move Name Options Print Quit Sort Transfer
           Value Window Xternal
Select option or type command letter
R2C1          BUDGET PLANNING              NL Multiplan  TEMP
```

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ware. For example, some users may think that a minimum requirement of 128K bytes for a word-processing application is excessive. Trends in software development, which provide new features (many approaching high-end dedicated word processors and typesetting systems) to less sophisticated users, however, will require at least this amount.

The system processor is powerful and fast. To test its speed, I ran the BASIC version of the Sieve of Eratosthenes prime-number program (see the January 1983 BYTE, page 286, listing 5) as a benchmark test. For 10 iterations of the Sieve program, the results were 940 seconds—less than half the time required for the IBM PC running Integer BASIC with an 8-bit bus at 4.77 MHz, according to the results published in the BYTE article. Speed is, of course, only one of many criteria to use when evaluating the performance of small systems. When considering soon-to-come hardware and user-friendly software developments, however, this factor takes on greater importance.

The Wang-developed word-processing program is superb. You would be hard-pressed to find a PC word-processing program that so successfully combines such ease of use with such sophisticated features.

Wang Laboratories designed the PC to adapt to all business and technical environments. The use of a nonstandard (read non-IBM) expansion-card format might prove a shortcoming, though. The availability of the technical reference manual, however, should rectify that problem.

Moreover, the Professional Computer is designed to be incorporated into Wang systems. As more PC systems are used in large-business environments, interconnecting with mainframes will be a growing demand. Wang has addressed that requirement already.

In the first half of 1984, Wang plans to release a local interconnection option, a combination of hardware and software that will permit Wang PCs to run in a shared mode. Each repeater card will support as many as eight PCs, and repeaters will be able to interconnect via RG-62A coaxial cable. This option will thus allow a total of 24 PCs to be interconnected.

Wang Laboratories has also produced some high-quality applications software, and the company is actively encouraging development of third-party software, much of which is already on the market. Thus, the amount of software available for the Wang PC should grow steadily.■

Photos 2 through 6 in this article are courtesy of Elphotec Computer Systems (Schiessgarten Str. 7, 6500, Mainz, West Germany).

Elaine Long (Fichteplatz 4, 6500, Mainz, West Germany) has a B.A. in Communications from the University of Delaware. She is an assistant editor at International Publications GmbH.

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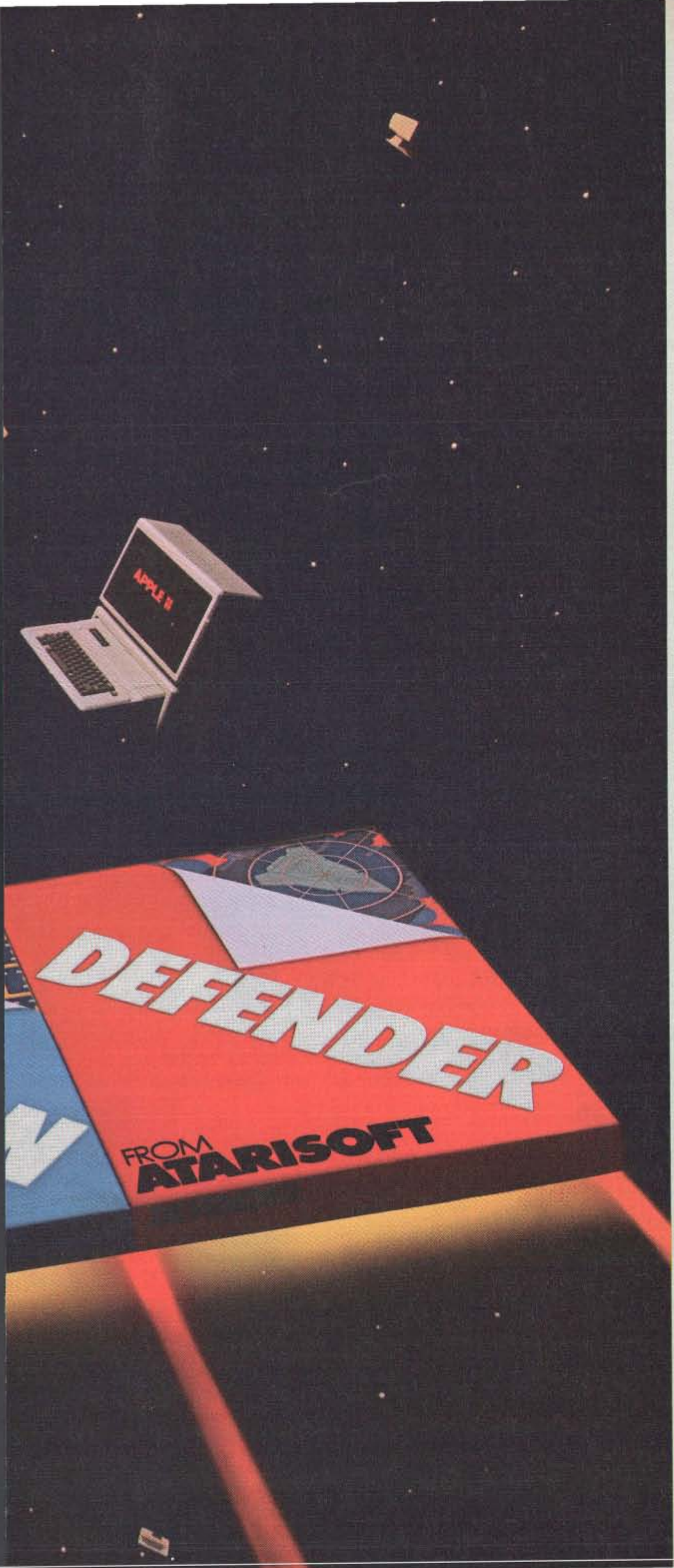

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ASM 2

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In Search of the Most Amazing Thing

An adventure game proves that the IBM PC isn't all business (the game also runs on Apple, Atari, and Commodore 64 machines)

by Elaine Holden

The advertisement reads: "Finally, aliens kids can reason with instead of destroy." Fulfilling that promise for children and adults accustomed to shoot-'em-up space games is a tall order. Intrigued but somewhat skeptical, I took the program home, plugged it into my IBM PC, and went on an adventure. And what an adventure!

In Search of the Most Amazing Thing was created by Tom Snyder Productions and is sold by Spinnaker Software. This educational adventure game encompasses an entire world called Porquatz. Half the world is very dull, but the other half, called the Darksome Mire, is covered by a "near mist," filled with deadly mire crabs, fascinating tribes, unusual and varied terrain, and erratic winds.

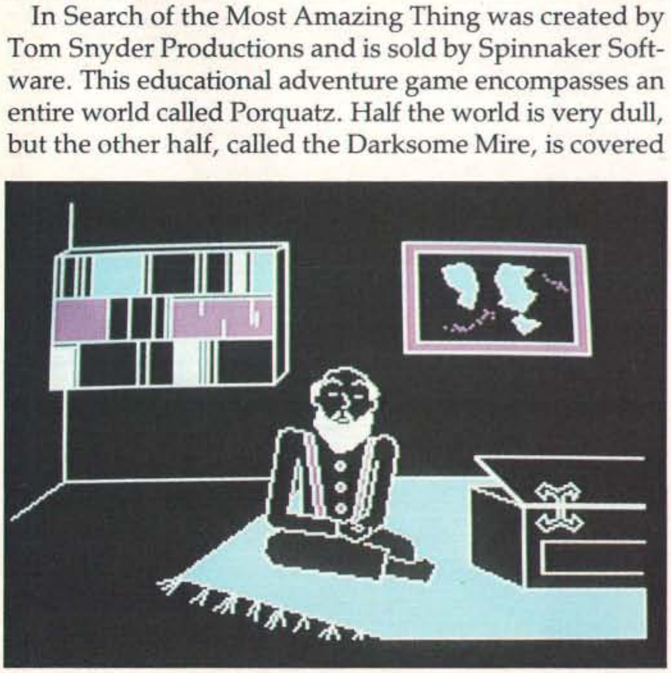


Photo 1: *Uncle Smoke's apartment. The chest next to Uncle contains treasures that can be auctioned off to the Metallicans.*

The game offers you this world to explore in your quest for a hidden object, and its consideration to details is extensive. The graphics are delightful and beautifully done. Along with them are comments and hints given by various citizens of Porquatz. Some clues are merely helpful, others are lighthearted as well. I delight in this type of adventure after being subjected to grimly determined games with a do-or-die, blast-them-out-of-the-sky attitude. If you don't want to be fighting star wars for the rest of your life, this adventure is right on the money.

The Journey Begins

The game involves a nonviolent search for an object called the Most Amazing Thing, lost by Uncle Smoke Bailey many years ago. Uncle Smoke, wishing you to bring this Most Amazing Thing back to his home in Metallica (a city in the Darksome Mire), provides you with a B-liner, a combination hot-air balloon and dune buggy. You must fly through storms, drive over land covered with bogs, deal with aliens, and create music before finding the Most Amazing Thing. Uncle Smoke also gives you plenty of advice as well as a jet pack for short trips outside the B-liner.

Every player begins the game atop a cement island in the middle of the Darksome Mire, standing next to the B-liner and a trap door. I entered the door and took

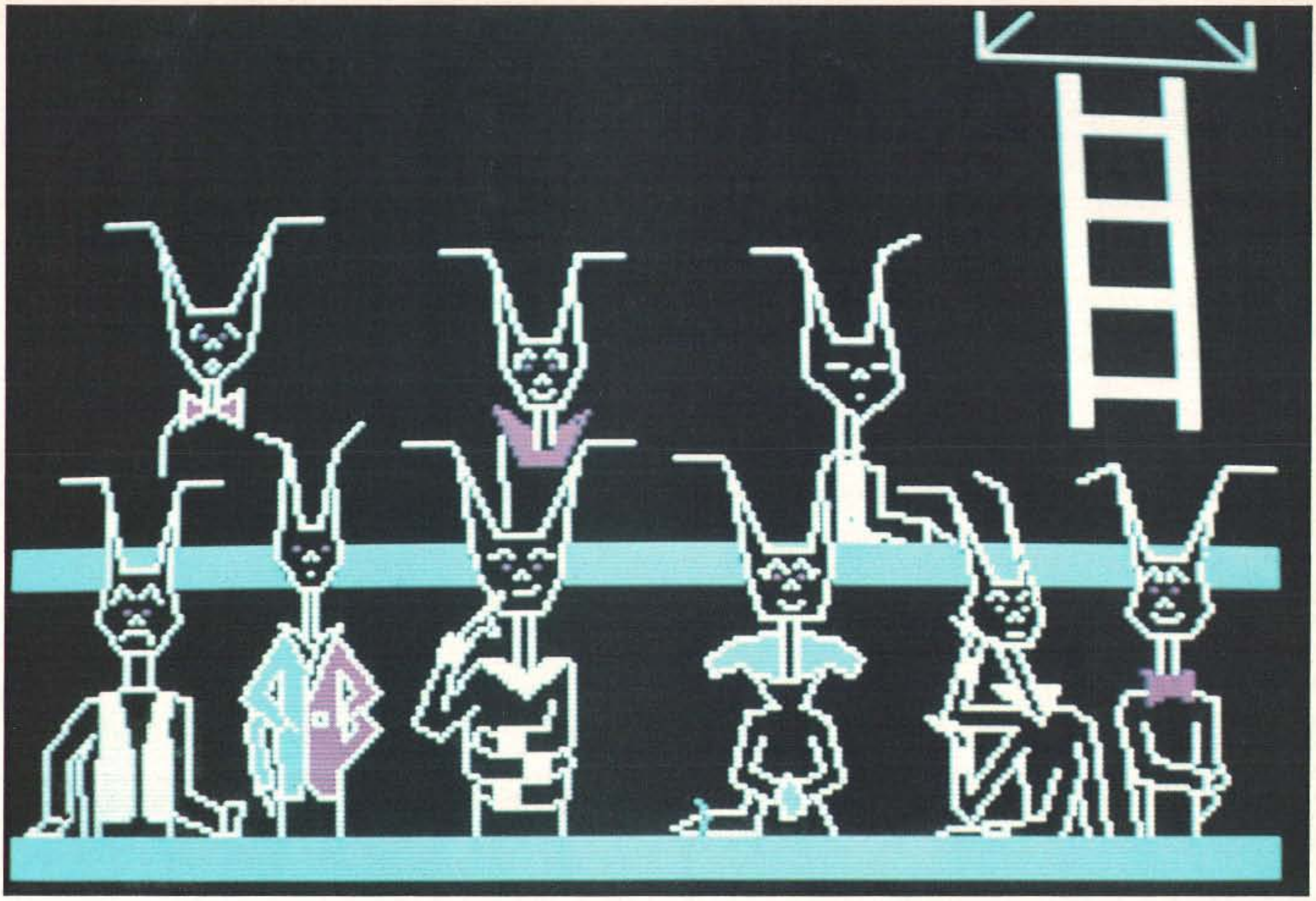


Photo 2: *The Metallican auction. The slippery folks pictured here can barter you out of treasures given to you by Uncle Smoke.*

a nearby elevator to the underground city of Metallica. The elevator allowed three stopping points: Uncle Smoke's apartment, the Galactic store, and the great Metallica auction. My first stop was the usual courtesy call to relatives in the neighborhood (see photo 1). Politeness paid off. Uncle Smoke gave me a clue to the whereabouts of the Most Amazing Thing and a petrified clam shell from Trellis Bog. Uncle suggested I sell the latter and keep notes of the clue. Bringing my relic to the auction (see photo 2), I proceeded to dicker with the Metallicans for the best price. (It took me a number of games to learn how to adjust my prices to realistic levels, and in the meantime those cagey fellows made off with several of my best treasures. The moral? Greed does not pay. Here's a hint: the auctioneer takes a single number from one to nine only.)

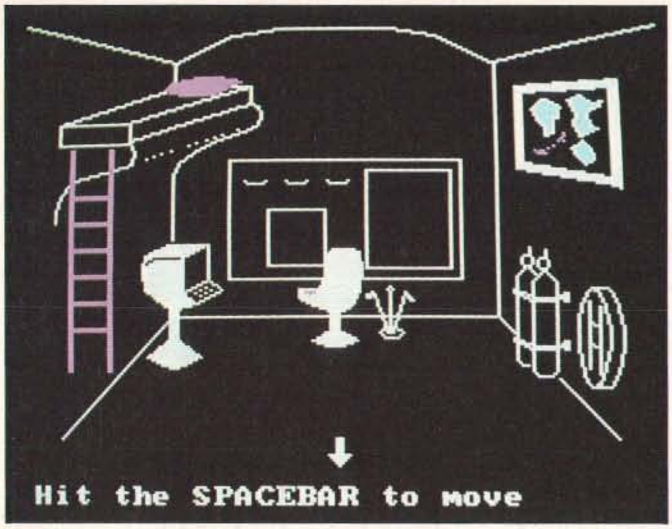
Eventually I accumulated sufficient chips for a trip to the Galactic Store. (All items and prices are listed in the instruction booklet as well as on the screen.) It is necessary to read the descriptions of items carefully. Some, such as the software packages Musix and Dicto, are necessary to communicate with the various cultures you will encounter and should be purchased. Others, such as the ultrasonic robot dog groomer, are luxury items only.

Inside the B-liner

Your first goal is to fully equip the B-liner (see photo 3) prior to takeoff. In order to maneuver, the machine needs navigation equipment, which must be purchased at the Galactic Store. You (the pilot) decide which meters to buy for outfitting the control panel (photo 4), then count your chips and begin purchasing software for the B-liner's on-board computer. And don't forget such packages as Musix and Dicto; surprisingly enough, several adults I know got into the game with a fully equipped flight-control panel and found themselves successfully flying over the Mire, but when they encountered aliens, they had no way to ask them clues or directions. (Conclusion: decision-making skills can be learned at all ages.)

After the B-liner is equipped, you are ready for takeoff. While flying over the Darksome Mire, you must carefully consider wind direction. The winds come from different directions at various heights, necessitating moving the B-liner up or down until the proper direction is found.

Interspaced with huts and mire crabs are night rocks and popberry trees for fuel and food, respectively. To fuel the ship, I had to land the B-liner on one of these rocks, get out, jockey my jet pack to the drill platform,



Hit the SPACEBAR to move

Photo 3: *The interior of the B-liner. Once in this compartment you can give various commands to operate the liner, leave, or communicate with different cultures.*

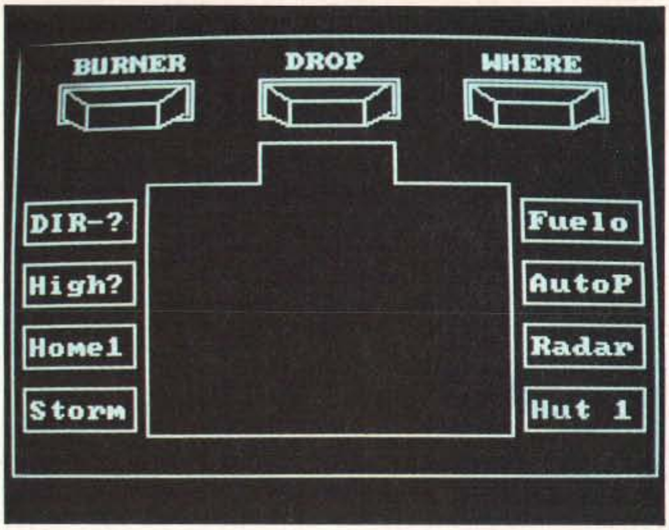


Photo 4: *The flight-control panel of the B-liner.*

and fuel up. Much the same procedure is required to eat (see photo 5), except that once I took the popberry off the tree, it often sank into the bog before I could navigate the jet pack down to it. Bitterly I watched a 12-year-old execute the maneuver perfectly and well within the time limit. Through perseverance, I managed to feed myself and then returned to the ship.

A Computer within a Computer

The software for the B-liner's computer is one of the most exciting parts of the game. The Map-H software, for example, locates every hut in the Mire. The Cults software contains facts about the people of each Mire culture, and Dicto translates important words and phrases used by all 25 cultures in the Darksome Mire. Musix is the software that shows you how to create songs, which are used for trading with the Mire cultures.

All cultures speak with their antennae. Dicto software shows the different shapes made to form words while also providing the corresponding tones. Six basic phrases are common to all cultures, but the symbols of each vary, according to the culture. Thus, the phrase "What is your quest?" can be expected from any culture, but the antenna patterns and tones vary.

Because each culture trades in Musix, you can make a song to trade with a culture in return for information. To do so, you draw any shape you want using the arrow keys, and when you finish, the picture and corresponding tones are played back, ready for trade. Cults software informs you as to the type of Musix the culture prefers.

World without End

Most adults experienced at playing computer games can complete this adventure in 10 to 12 hours. Two or more 10-year-olds (up to an entire class) working together can get through it in 20 to 30 hours. Lest you think the game can be shelved once you've found the Most Amazing Thing, tricky ol' Tom Snyder, creator of this highly enjoyable fantasy, has designed the program to change the location of the Most Amazing Thing every time the game is played. You can, of course, stop the game any time you wish and save your position so as to return later and carry on where you left off.

The adventures and experiences are richly entertaining and vary tremendously each time you play. The game convinces me that in an adventure violence is unnecessary to keep the imagination and intellect enthralled.

Adventure in the Classroom

In Search of the Most Amazing Thing should not be considered just an adventure game, however. The educational applications are numerous and, to a teacher, just as exciting.

One of the battles teachers fight every day is getting students to understand the value of note taking. To be able to instantly produce a historic date or obscure fact is not reason enough for most students to perform the exhaustive task of putting pen to paper.

Since this fact dawned on educators, they have been frantically trying to find relevant and interesting information that students will wish to retain. This program should provide the important motivation necessary for teaching note taking. Adventurers must recall, for example, all the advice from Uncle Smoke as well as information about the various cultures. Careful records must be kept on music preferences and antenna patterns. Organization of these notes for quick reference is critical.

Records of the amount of chips in your possession also prove very handy. Basic math is required when dealing with chips both during the auction and when trading with the cultures in the Mire. Players must further exercise their computational skills when evaluating meter readings and interpreting map coordinates.

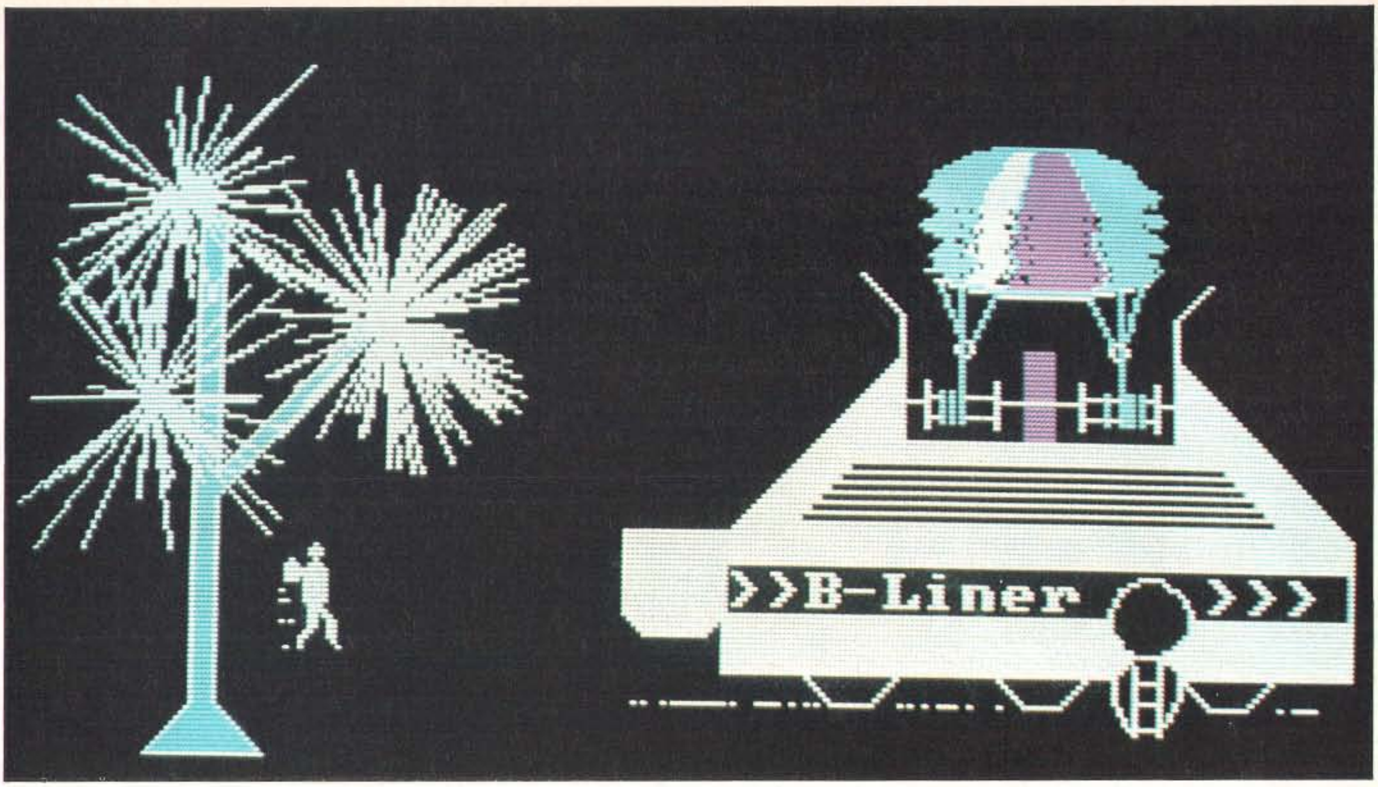


Photo 5: *An adventurer (in jet pack) leaves the liner and flies to a popberry tree to eat. (Navigation takes talent; find a 12-year-old to show you how.)*

Map-making and map-reading skills, essential to the study of any culture, are also an important part of this game. Often children do not recognize the value of maps because many school systems today do not have adequate geography programs. The world of In Search of the Most Amazing Thing may be one of the few places a child can painlessly learn the basic skills as well as the value of map reading.

Cultures are always associated with maps and travel. The game's 25 cultures prefer different types of music, speak different languages, and impart various pieces of advice. They also teach a valuable lesson. Underneath the dissimilar culture trappings, such as music and language, the cultures are in many ways the same.

Young people often don't get to see beyond the superficial differences between societies and seldom recognize the tremendous similarities of all people. Social-studies programs try to go beyond those differences; this game is another tool to help them succeed.

Throughout the adventure, decisions must be made. Good decision making is a learned skill; it isn't just randomly acquired. A simulation game, setting up decision-making situations, enables students to evaluate alternatives and make judgments. In real life, poor decisions can be costly or dangerous; in simulation games, students can get experience without undue punishment for errors.

In Search of the Most Amazing Thing also encourages reading by including a storybook. Players do not have to read the book to go on the adventure. Once you start adventuring, though, this book, written at about the fifth-grade level, is a delightful addition to the program. The computer simulates the planet's environment, and the book complements it with details and background information.

Name Your System

The program runs on a 64K-byte IBM PC, a 48K-byte Apple, and a 48K-byte Atari. I have found that most features of the game are identical for all three microcomputers, but although the Atari has excellent sound qualities, it runs the slowest of the three. The Apple is second in speed, and the IBM PC is by far the fastest. It also has the capacity for a much wider variation in sounds. I would certainly recommend the game for use on any of these systems, but if you own an IBM PC and have been dutifully handling bookkeeping transactions, be advised: the IBM isn't just for business any more. The PC and the Most Amazing Thing seem to be made for each other. (Although a translation is now available for the Commodore 64, an overview of its performance is not included in this discussion.)

Map-making and map-reading skills are also an important part of this game.

Summary

In Search of the Most Amazing Thing is an exciting adventure filled with interaction among cultures, harrowing balloon flights, and opportunities for creating

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At a Glance

Name
In Search of the Most Amazing Thing

Type
A learning/adventure game

Manufacturer
Spinnaker Software Corporation
215 First St.
Cambridge, MA 02142
(617) 868-4700

Price
$39.95

Format
5¼-inch floppy disk

Documentation
14-page instruction booklet, 76-page storybook, and a quick-reference card for your specific computer

Language
BASIC

Computer Needed
Apple II, II Plus, or IIe; Atari 800 or 1200, Commodore 64, or IBM Personal Computer

Audience
Adventurers, ages 10 to adult; teachers, especially in social studies and world cultures or those dealing with gifted and talented students

music, making judgments, and traveling over an entire world.

The graphics in the program are well designed and executed.

In addition to providing a colorful adventure, the game is a valuable educational tool. Successful players take notes, employ mathematical skills, and initiate social interactions.

An accompanying storybook rounds out the educational aspects of the program; it is nonthreatening, however, simply because its use is optional.

The program has wide appeal for ages 10 through adult. Educators can benefit from this program by involving an entire class in the adventure.

In Search of the Most Amazing Thing also clearly points out the versatility of the IBM PC as an educational tool, a recreational computer, *and* a business machine.

I highly recommend this game for the educational opportunities it provides as well as the exciting yet nonviolent adventures. A player can be taught valuable skills through this program and have a terrific time as well.■

Elaine Holden (22 Elm St., Peterborough, NH 03458) is supervisor of reading and language arts at the Merrimack School District, Merrimack, New Hampshire.

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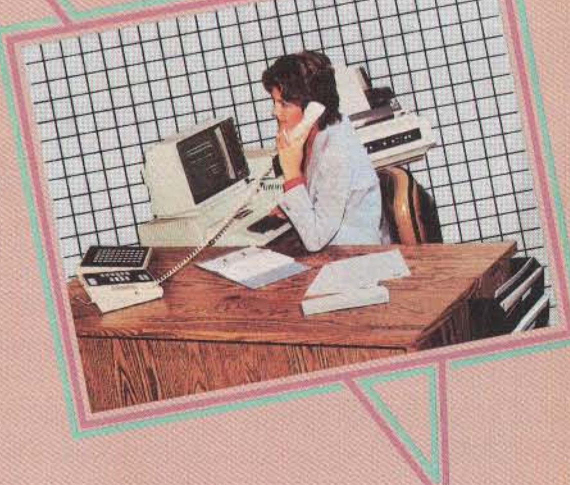

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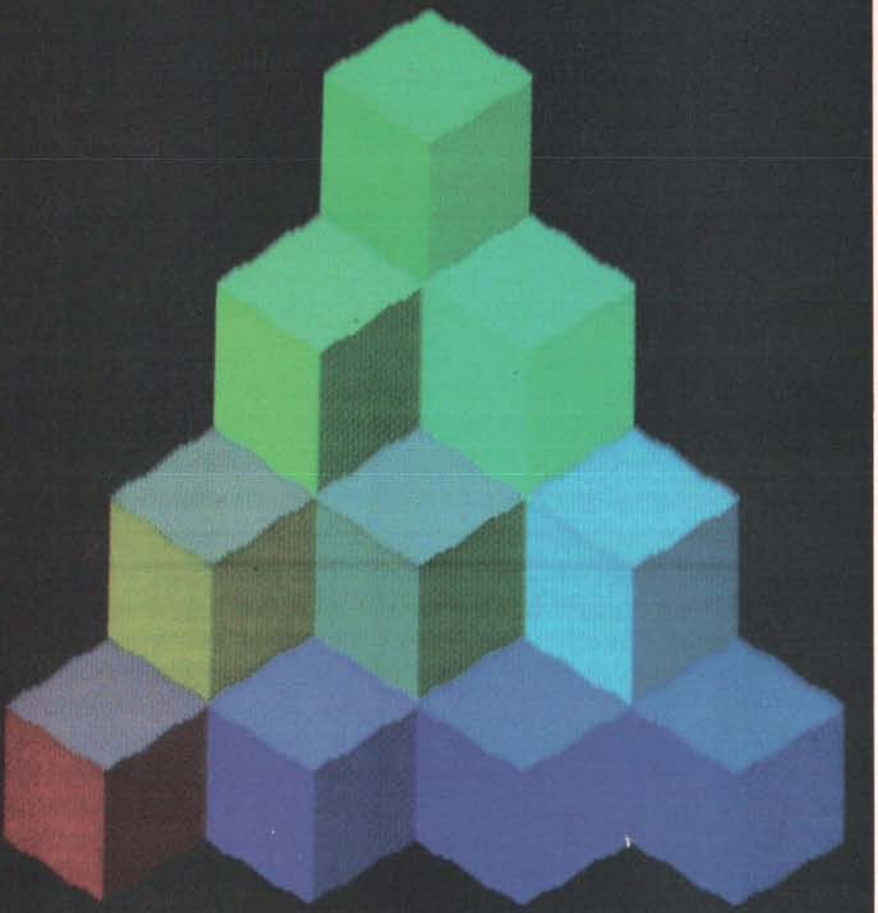

Color Graphics From Any Computer

Full-color photography from a black-and-white display

by Frederick B. Essig

When many of us think about color graphics, we often think in terms of one of the popular computers that has built-in color graphics capabilities. Connected to a color TV or monitor, these machines indeed put on a dazzling color display. From games to computer-assisted design, color is a great enhancement for nearly all interactive or real-time computer applications.

Another use of color graphics, however, is the creation and subsequent transfer of graphic images to photographic film. Here we are more apt to be concerned with resolution and color quality (see photos 1, 2, and 3) than we are with interactive considerations. Specific applications of computer-to-film recording include preparation of transparencies for educational or business presentations (see photos 4 and 5), creation of serious works of art, and, if you have a great deal of patience, the making of animated films.

The process described here is not particularly easy to employ, at least not at first. The drawing and editing processes are tricky and can be tedious, and you must be prepared to spend some time fiddling with the camera, tripod, filters, and other equipment. But the quality of the final product is unquestionably superior to simple display photography; compared with other, noncomputer means of preparing detailed graphics, the time involved is minimal. For owners of black-and-white computers, this is also a means of getting into color graphics with a small investment. All of the photos in this article were produced using this process.

Photographing a color TV screen or monitor has some serious limitations. You can, of course, simply set a camera in front of the display and snap the shutter. But pictures tend to be grainy, colors tend to bleed, and,

Photo 1: *A simulated three-dimensional color triangle showing gradations of color and shading between red, green, and blue was created by a color-separation process on the black-and-white screen of an Osborne 1 portable computer.*

with many microcomputers, you are restricted to a relatively few colors on the screen at one time. Subtle hues and realistic shading are not available. Of course, the more money you invest in equipment, the better your pictures can be because larger systems enable use of more colors and expensive RGB (red-green-blue) monitors minimize graininess and bleeding. The method I use, however, lets you create color pictures with the sharpness inherent in a good black-and-white monitor, with as many colors as you want in every picture. The method can be employed with virtually any personal computer on the market, using a black-and-white monitor or TV. All of the photos accompanying this article were made with an Osborne 1 computer and photographed from its built-in monitor.

The key to this process is color separation. Any color picture can be broken down into three monochrome images that later can be recombined to form the original color picture. In the early days of color photography, three black-and-white negatives were exposed simultaneously through red, green, and blue filters; these negatives were then used to make superimposed images on paper with cyan, magenta, and yellow dyes (the complementary colors of red, green, and blue). Modern color films consist of a sandwich of cyan, magenta, and yellow monochrome images. Televisions and monitors use a variation of this process: red, green, and blue images are received by the TV and cause red, green, and blue dots to light up on the screen. By varying the intensities of each of the three primary colors, a full range of colors is created.

Color-separation techniques are not new in computers. Sophisticated (and expensive) systems have been used for several years to produce very high-resolution pictures and films such as Disney's *Tron*. The computer separates a color image into three

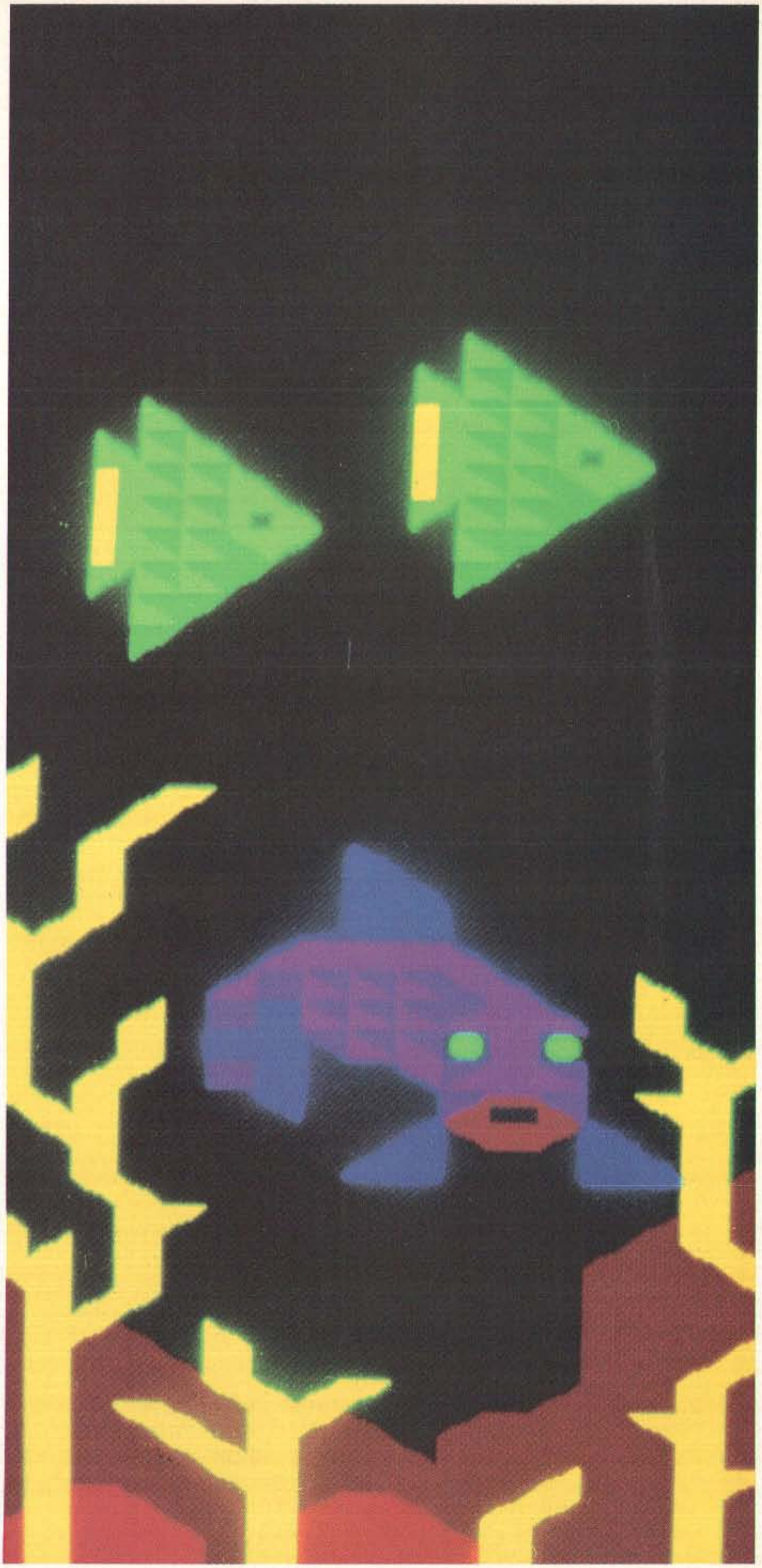

Photo 2: *"Fish and Coral" is an example of the artistic capabilities of the author and his process. This image was created without using the subtle shading shown in photo 1.*

black-and-white images, each of which is then displayed separately on a very high-resolution black-and-white monitor and then combined photographically onto color film. Recently, Polaroid has introduced special photographic hardware that similarly makes high-resolution hard copy of color computer graphics.

The technique outlined here is an inexpensive, do-it-yourself application of color-separation photography for microcomputers. The only extra "hardware" you need, besides a camera, is a set of color-separation filters: Kodak wratten #29 (red), #61 (green), and #47B (blue). A genuine black-and-white display is needed; green or amber screens create serious problems with color balance. Listing 1 and this article should help you develop a program in BASIC that will run on your computer and let you create a picture containing up to 1000 different colors. The text box at left guides you through the actual display and photography processes.

A program to employ this technique consists of two parts. The first part is a drawing program that creates a color picture in the memory of the computer while simultaneously drawing a black-and-white approximation of that picture on the screen. The picture in memory will be saved as an *x,y* dimensioned array that contains a color code and character code (in low-resolution mode) for each pixel. The second part of the program (or a separate program) then

Text continued on page 392

Using the Supercolor Program

1. Insert the MBASIC disk in drive A; insert the disk with the Supercolor program in drive B; if you're creating a new picture, be sure the disk in drive B has enough space (you can use as much as 24K bytes).
2. First menu: Choose whether you are creating a new picture, modifying an existing picture (disk or memory), or doing photography (disk or memory).
3. Provide a standard filename for a new or stored picture when prompted.
4. Choose the screen mode when prompted: mode one is screen one with only a rectangular symbol available; mode two is screen two only, full-character operation, black background only; mode three uses two screens, block character in screen one for background colors, full-character operation in screen two; mode four is full-character operation in both screens—use this for putting two characters in one pixel.
5. Enter a three-digit color code for background (000 in modes one and two) when asked.
6. Choose which screen to edit when asked; begin usually with screen two, which is the main picture screen.
7. Editing commands: # enters into lettering mode from graphics mode; **esc** *returns to graphics mode;* **tab** *brings up the "color" prompt; enter a three-digit color code for characters to be drawn and then key* **Return**. *Press any letter key to choose a graphics symbol, according to the keyboard scheme in the Osborne users manual; use arrow keys to enter that character in the previously chosen color as many times as desired.* **!** *saves characters on screen one instead of screen two; key* **%** *to return to screen two. Use the* **(** *key to see what is on screen one; use the* **)** *key to return to screen two. Push the space bar to move the cursor across the screen and to read colors recorded for each location; return to drawing mode by selecting a new character. The hyphen key enters delete mode; choose another character to return.* + *saves the picture to disk and returns to editing. Key* **esc** *to save and quit.*
Note: Keep an eye on the "bytes =" prompt. If the number of free bytes approaches zero, save the picture to disk, restart the program, and reload from disk.
8. Photographing a picture: Use the "focus-grid" prompt to standardize the brightness of the screen with an exposure meter (e.g., adjust brightness so that the needles match at 1/15th second at f 3.5 for ISO 64 film); use the "preview" prompt to center the picture with the camera. When the "ready to photograph (red first-push return)" prompt appears, put a red filter over the camera lens, check the settings (try f11 for ISO 64 film), turn off the lights, key **Return**. *At the end of six beeps, lock open the shutter.*

When the last of the red picture disappears from the screen, put a green filter over the camera lens (the camera shutter is still open), key **0**. *When the green picture disappears, put a blue filter on the lens. After the blue picture, close the shutter and key* **Return**. *Cross your fingers and develop the film.*

Listing 1: *The Supercolor program in MBASIC for the Osborne 1. A few items are machine-dependent; see the text for details.*

```
10 GOTO 70
20 Y=INT((A-HOME)/128):X=A-HOME-Y*128
25 IF SCREEN=2 THEN K$(X,Y)=KL$:L%(X,Y)=T:RETURN
30 IF T=32 THEN C$(X,Y)=CB$ ELSE C$(X,Y)=KL$
40 BK%(X,Y)=T:RETURN
70 DIM C$(52,23),K$(52,23),L%(52,23),BK%(52,23)
80 HOME=61568!:REM *UPPER LEFT CORNER OF PICTURE AREA*
90 PRINT CHR$(26):PRINT "MENU"
100 PRINT "1. CREATE PICTURE"
110 PRINT "2. PHOTOGRAPH PICTURE FROM DISK"
120 PRINT "3. MODIFY EXISTING PICTURE FROM DISK"
130 PRINT "4. PHOTOGRAPH PICTURE FROM MEMORY"
140 PRINT "5. MODIFY EXISTING PICTURE IN MEMORY"
150 INPUT "TYPE NUMBER OF SELECTION";N
160 ON N GOTO 170,460,2100,630,2120
170 W=1:PRINT:INPUT "NAME OF NEW PICTURE";PICT$
```

Listing 1 continued on page 384

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Listing 1 continued:

```
180 PRINT "MODE MENU"
190 PRINT "1. BACKGROUND/PATTERN"
200 PRINT "2. FOREGROUND ONLY"
210 PRINT "3. FOREGROUND AND BACKGROUND"
220 PRINT "4. DOUBLE MODE"
230 INPUT "TYPE NUMBER OF CHOICE";MODE
240 PRINT CHR$(26):INPUT "SET BACKGROUND COLOR";CB$
245 PRINT"WAIT - INITIALIZING"
250 FOR Y=0 TO 22
260 FOR X=0 TO 51
270 IF MODE=1 THEN C$(X,Y)=CB$
272 IF MODE=2 THEN K$(X,Y)=CB$:L%(X,Y)=32
274 IF MODE=3 THEN C$(X,Y)=CB$:K$(X,Y)="":L%(X,Y)=32
276 IF MODE=4 THEN C$(X,Y)="000":K$(X,Y)="000":L%(X,Y)=32:BK%(X,Y)=32
290 NEXT X
300 NEXT Y
310 GOTO 2120
320 GOSUB 340
330 GOTO 90
340 OPEN "O",1,PICT$
350 PRINT #1, MODE;","; CB$
360 FOR Y= 0 TO 22
370 FOR X=0 TO 51
380 IF MODE=1 THEN PRINT #1, C$(X,Y)
390 IF MODE=2 THEN PRINT #1, K$(X,Y);",";L%(X,Y)
400 IF MODE=3 THEN PRINT #1, C$(X,Y);",";K$(X,Y);",";L%(X,Y)
410 IF MODE=4 THEN PRINT #1, C$(X,Y);",";K$(X,Y);",";L%(X,Y);",";BK%(X,Y)
420 NEXT X
430 NEXT Y
440 CLOSE
450 RETURN
460 PRINT CHR$(26)
470 INPUT "NAME OF PICTURE TO PHOTOGRAPH";PICT$
480 GOSUB 500
490 GOTO 630
500 OPEN "I",1,PICT$
510 INPUT #1, MODE,CB$
515 PRINT CHR$(26); "LOADING LINE #"
520 FOR Y=0 TO 22
530 FOR X=0 TO 51
540 IF MODE=1 THEN INPUT #1, C$(X,Y)
550 IF MODE=2 THEN INPUT #1, K$(X,Y),L%(X,Y)
560 IF MODE=3 THEN INPUT #1,C$(X,Y),K$(X,Y),L%(X,Y)
570 IF MODE=4 THEN INPUT #1, C$(X,Y),K$(X,Y),L%(X,Y),BK%(X,Y)
590 NEXT X
595 PRINT Y;CHR$(30)
600 NEXT Y
610 CLOSE
620 RETURN
630 PRINT CHR$(26)
640 REM *FOCUS SCREEN*
650 INPUT " DO YOU WANT THE FOCUS GRID";GRD$
660 IF GRD$="Y" THEN 680 ELSE 770
680 FOR Y=0 TO 23
690 FOR X=0 TO 51
700 POKE HOME+X+Y*128,22
710 NEXT X
720 NEXT Y
730 X=25:Y=11:POKE HOME+X+128*Y,0
740 X=0:Y=0: POKE HOME+X+128*Y,0
750 X=51:Y=0:POKE HOME+X+128*Y,0
```

Listing 1 continued on page 386

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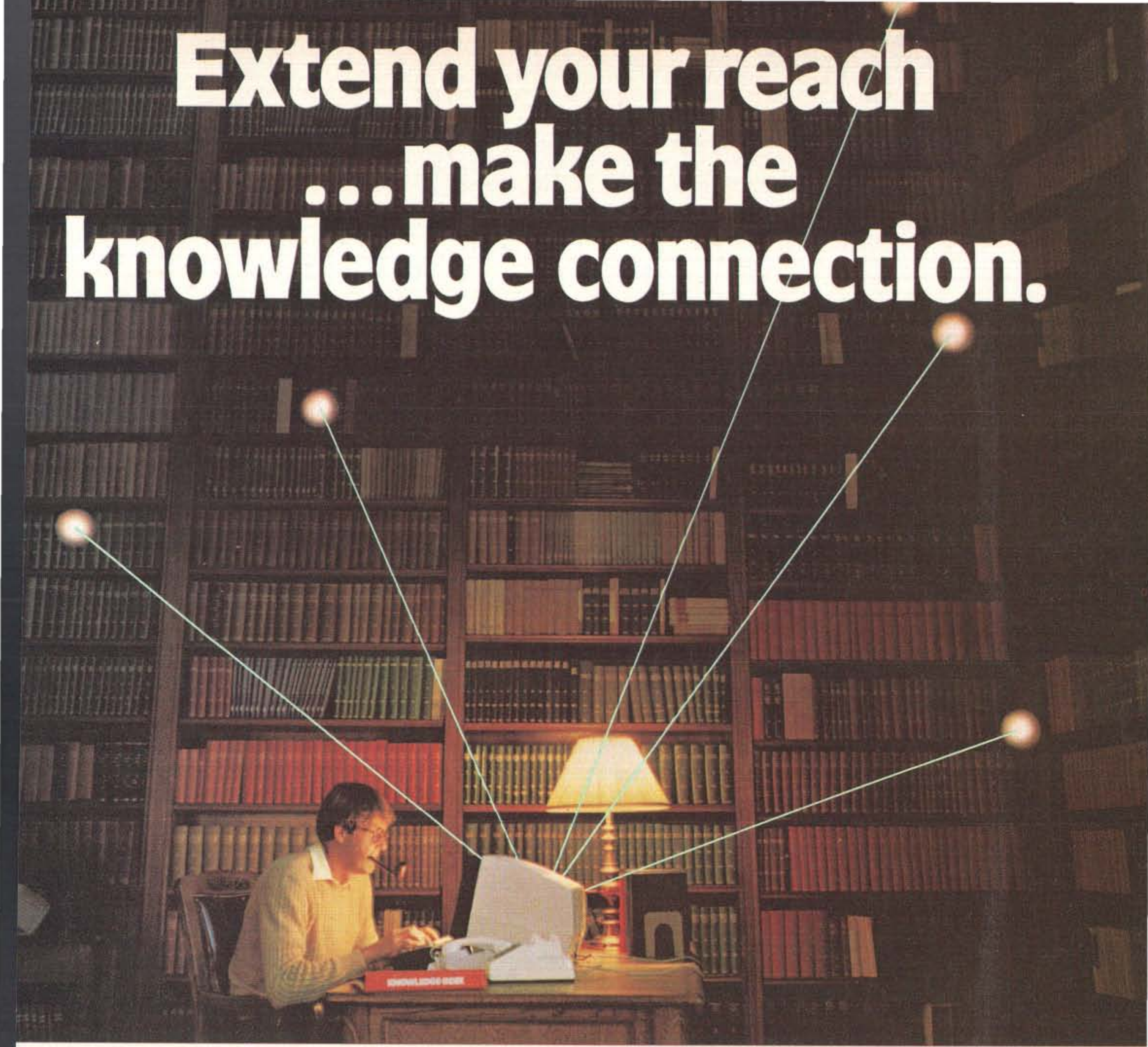
Circle 94 on inquiry card.

Listing 1 continued:

```
760 INPUT Q$
770 INPUT "DO YOU WANT TO PREVIEW PICTURE";PRV$
780 IF PRV$="Y" THEN GOSUB 2140 ELSE GOTO 810
800 INPUT "ANY CORRECTIONS";CORR$:IF CORR$="Y" THEN GOTO 2290
810 PRINT CHR$(26):INPUT "READY TO PHOTOGRAPH (RED FIRST-PUSH RETURN)";ANS$
820 PRINT CHR$(26)
830 FOR N=0 TO 5
840 PRINT CHR$(7)
850 FOR T=1 TO 1000:NEXT T
860 NEXT N
870 PRINT CHR$(26):POKE HOME,32
880 IF MODE=2 THEN 1080
890 IF MODE<4 THEN S=22
895 N=HOME
900 FOR Y=0 TO 22
910 FOR X=0 TO 51
930 IF MODE=4 THEN S=BK%(X,Y)
940 R=VAL(LEFT$(C$(X,Y),1))
950 IF R=0 THEN 965
960 POKE N,S
965 N=N+1
970 NEXT X
975 N=N+76
980 NEXT Y
990 FOR T=1 TO 9
995 N=HOME
1000 FOR Y=0 TO 22
1010 FOR X=0 TO 51
1030 IF T>=VAL(LEFT$(C$(X,Y),1)) THEN POKE N,32
1035 N=N+1
1040 NEXT X
1045 N=N+76
1050 NEXT Y
1060 NEXT T
1070 IF MODE=1 THEN 1250
1075 N=HOME
1080 FOR Y=0 TO 22
1090 FOR X=0 TO 51
1100 IF L%(X,Y)=32 THEN 1135
1110 IF VAL(LEFT$(K$(X,Y),1))=0 THEN 1135
1130 POKE N,L%(X,Y)
1135 N=N+1
1140 NEXT X
1145 N=N+76
1150 NEXT Y
1160 FOR T=1 TO 9
1165 N=HOME
1170 FOR Y=0 TO 22
1180 FOR X=0 TO 51
1200 IF T>=VAL(LEFT$(K$(X,Y),1)) THEN POKE N,32
1205 N=N+1
1210 NEXT X
1215 N=N+76
1220 NEXT Y
1230 NEXT T
1250 I$=INKEY$
1260 IF I$="0" THEN GOTO 1280
1270 GOTO 1250
1280 IF MODE=2 THEN 1480
1290 IF MODE<4 THEN S=22
1295 N=HOME
```

Listing 1 continued on page 388



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Circle 502 on inquiry card.

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Listing 1 continued:

```
1300 FOR Y=0 TO 22
1310 FOR X=0 TO 51
1330 IF MODE=4 THEN S=BK%(X,Y)
1340 G=VAL(MID$(C$(X,Y),2,1))
1350 IF G=0 THEN GOTO 1365
1360 POKE N,S
1365 N=N+1
1370 NEXT X
1375 N=N+76
1380 NEXT Y
1390 FOR T=1 TO 9
1395 N=HOME
1400 FOR Y=0 TO 22
1410 FOR X=0 TO 51
1430 IF T>=VAL(MID$(C$(X,Y),2,1)) THEN POKE N,32
1435 N=N+1
1440 NEXT X
1445 N=N+76
1450 NEXT Y
1460 NEXT T
1470 IF MODE=1 THEN 1650
1475 N=HOME
1480 FOR Y=0 TO 22
1490 FOR X=0 TO 51
1510 IF VAL(MID$(K$(X,Y),2,1))=0 THEN 1535
1530 POKE N,L%(X,Y)
1535 N=N+1
1540 NEXT X
1545 N=N+76
1550 NEXT Y
1560 FOR T=1 TO 9
1565 N=HOME
1570 FOR Y=0 TO 22
1580 FOR X=0 TO 51
1600 IF T=>VAL(MID$(K$(X,Y),2,1)) THEN POKE N,32
1605 N=N+1
1610 NEXT X
1615 N=N+76
1620 NEXT Y
1630 NEXT T
1650 I$=INKEY$
1660 IF I$="0" THEN GOTO 1680
1670 GOTO 1650
1680 IF MODE=2 THEN 1880
1690 IF MODE<4 THEN S=22
1695 N=HOME
1700 FOR Y=0 TO 22
1710 FOR X=0 TO 51
1730 IF MODE=4 THEN S=BK%(X,Y)
1740 B=VAL(RIGHT$(C$(X,Y),1))
1750 IF B=0 THEN 1770
1760 POKE N,S
1770 N=N+1: NEXT X
1775 N=N+76
1780 NEXT Y
1790 FOR T=1 TO 9
1795 N=HOME
1800 FOR Y=0 TO 22
1810 FOR X=0 TO 51
1830 IF T=VAL(RIGHT$(C$(X,Y),1)) THEN POKE N,32
1835 N=N+1
```

Listing 1 continued on page 390

Circle 256 on inquiry card. →

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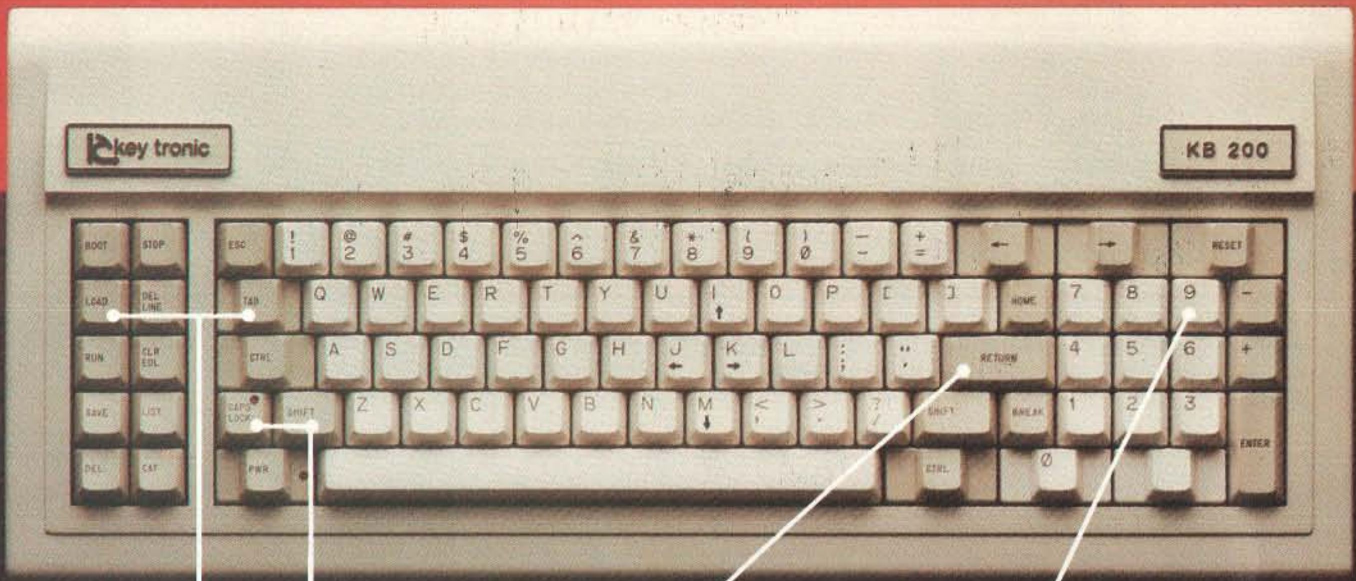

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Listing 1 continued:

```
1840 NEXT X
1845 N=N+76
1850 NEXT Y
1860 NEXT T
1870 IF MODE=1 THEN 2040
1875 N=HOME
1880 FOR Y=0 TO 22
1890 FOR X=0 TO 51
1900 IF L%(X,Y)=32 THEN 1940
1910 IF VAL(RIGHT$(K$(X,Y),1))=0 THEN 1940
1930 POKE N,L%(X,Y)
1940 N=N+1:NEXT X
1945 N=N+76
1950 NEXT Y
1960 FOR T=1 TO 9
1965 N=HOME
1970 FOR Y=0 TO 22
1980 FOR X=0 TO 51
2000 IF T=VAL(RIGHT$(K$(X,Y),1)) THEN POKE N,32
2005 N=N+1
2010 NEXT X
2015 N=N+76
2020 NEXT Y
2030 NEXT T
2040 G$=INKEY$:IF INKEY$="" THEN 2040
2090 GOTO 90
2100 INPUT "NAME OF PICTURE TO MODIFY";PICT$
2110 GOSUB 500
2120 GOSUB 2140
2130 GOTO 2290
2140 INPUT"SHOW BACKGROUND(1) OR FOREGROUND(2)";SCREEN
2150 PRINT CHR$(26)
2160 FOR X=0 TO 51
2170 POKE HOME+X+128,42: POKE HOME+X+2816,42:NEXT X
2180 FOR Y=1 TO 21
2190 POKE HOME+Y*128,42: POKE HOME+Y*128+51,42:NEXT Y
2200 IF W=1 THEN 2280
2210 FOR Y=2 TO 21
2220 FOR X=1 TO 50
2230 N=HOME+X+128*Y
2240 IF SCREEN=1  THEN D=BK%(X,Y) ELSE D=L%(X,Y)
2250 POKE N,D
2260 NEXT X
2270 NEXT Y
2280 W=0: RETURN
2290 A=HOME+258
2300 POKE A,0
2305 PRINT "COLOR=";KL$;TAB(12) "BYTES=";FRE(0);
2307 PRINT TAB(30) "SYMBOLS"; TAB(44) "SCREEN=";SCREEN;CHR$(30)
2310 A$=INKEY$:IF LEN(A$)=0 THEN 2310
2320 IF A$=CHR$(12) THEN POKE A,T:GOSUB 20:A=A+1
2330 IF A$=CHR$(8) THEN POKE A,T:GOSUB 20:A=A-1
2340 IF A$=CHR$(11) THEN POKE A,T:GOSUB 20:A=A-128
2350 IF A$=CHR$(10) THEN POKE A,T:GOSUB 20:A=A+128
2360 IF A$=" " THEN GOTO 2640
2365 IF A$="-" THEN T=32
2370 IF A$="+" THEN GOSUB 340
2380 IF A$=CHR$(9) THEN GOSUB 2490
2390 IF A$="!" THEN SCREEN=1:PRINT "COLOR=";KL$;
TAB(12) "PRINTING ALTERNATE SCREEN";CHR$(30)
2400 IF A$="%" THEN SCREEN=2:GOTO 2305
```

Listing 1 continued on page 392

LOW-COST RS-232 NETWORKING.

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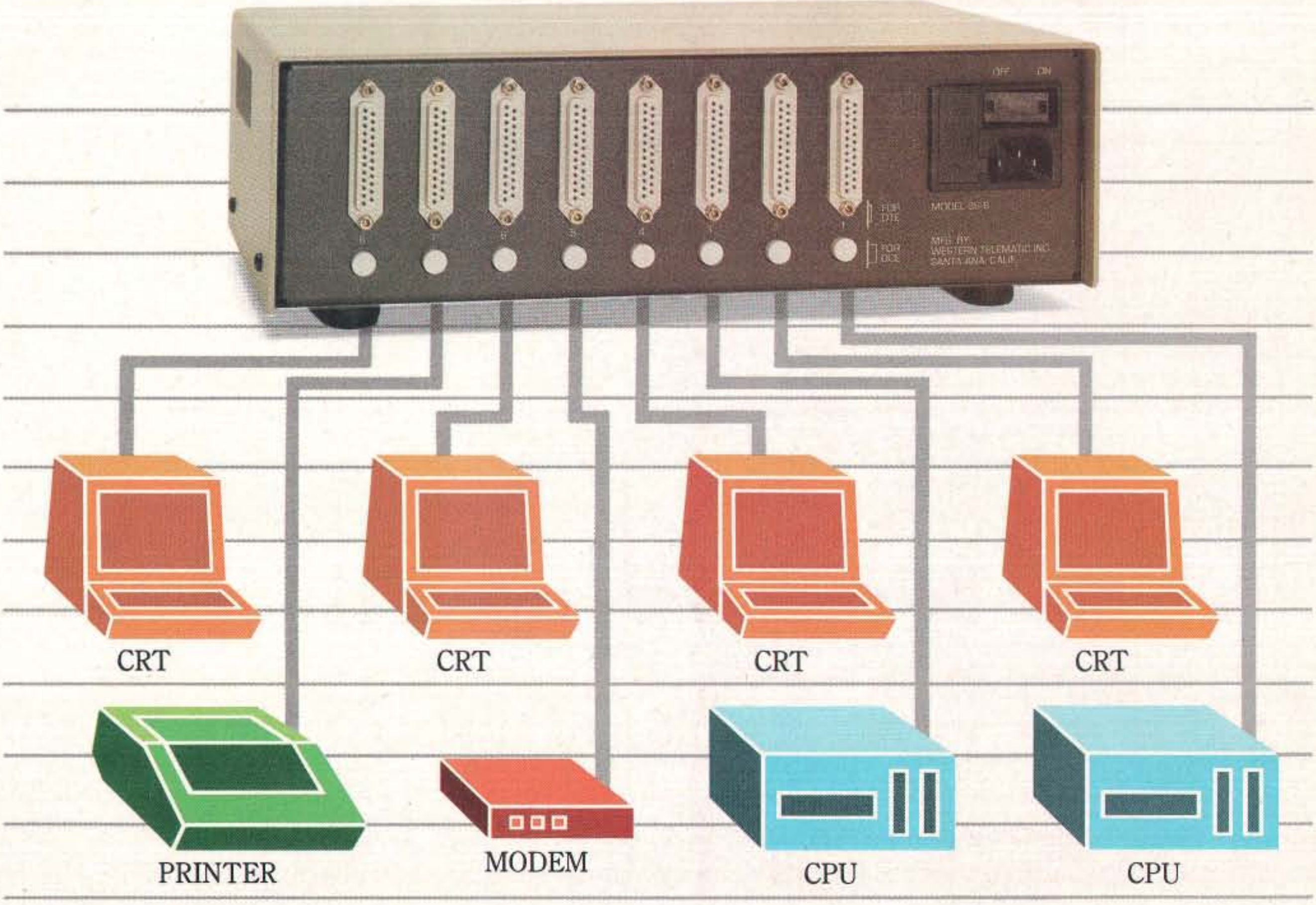

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Circle 455 on inquiry card.

Listing 1 continued:

```
2410 IF A$="?" THEN T=127
2420 IF A$="(" THEN SCREEN=1:GOSUB 2150
2430 IF A$=")" THEN SCREEN=2:GOSUB 2150
2440 IF A$="#" THEN GOSUB 2510
2460 IF A$=CHR$(27) THEN GOTO 320:REM *PUSH ESC TO SAVE,QUIT*
2470 IF ASC(A$)>=64 THEN T=ASC(A$)-64
2480 GOTO 2300
2490 PRINT CHR$(27)+")";CHR$(30):INPUT "COLOR=";KL$:
PRINT CHR$(27)+"(";CHR$(30)
2500 RETURN
2510 PRINT"       color=";KL$;"   LETTERING MODE";CHR$(30)
2520 B$=INKEY$:IF LEN(B$)=0 THEN 2520
2530 IF B$=CHR$(27) THEN RETURN
2540 IF B$=CHR$(8) THEN A=A-1:POKE A,0:POKE A+1,32:GOTO 2520
2550 IF B$=CHR$(12) THEN A=A+1:POKE A,0:POKE A-1,32:GOTO 2520
2560 IF B$=CHR$(11) THEN A=A-128:POKE A,0:POKE A+128,32:GOTO 2520
2570 IF B$=CHR$(10) THEN A=A+128:POKE A,0:POKE A-128,32:GOTO 2520
2580 IF B$=CHR$(9) THEN GOSUB 2490
2590 T=ASC(B$)
2600 POKE A,T
2610 GOSUB 20
2620 A=A+1:POKE A,0
2630 GOTO 2520
2640 PRINT "                       COLOR SCAN";CHR$(30)
2650 Y=INT((A-HOME)/128):X=A-HOME-Y*128
2660 PRINT "C0L0R=";K$(X,Y);TAB(15) "BACKGROUND =";C$(X,Y);
"                    ";CHR$(30)
2670 TEMP=L%(X,Y)
2680 J$=INKEY$:IF J$="" THEN 2680
2700 IF J$=CHR$(12) THEN A=A+1:POKE A,0:POKE A-1,TEMP:GOTO 2650
2710 IF J$=CHR$(8) THEN A=A-1:POKE A,0:POKE A+1,TEMP:GOTO 2650
2720 IF J$=CHR$(11) THEN A=A-128:POKE A,0:POKE A+128,TEMP:GOTO 2650
2730 IF J$=CHR$(10) THEN A=A+128:POKE A,0:POKE A-128,TEMP:GOTO 2650
2735 IF ASC(J$)>=64 THEN T=ASC(J$)-64:GOTO 2305
2736 IF J$="-" THEN T=32:GOTO 2305
2740 GOTO 2680
```

Text continued from page 382:

separates the picture into three black-and-white images, which represent the three primary colors, and displays them one at a time for the camera.

The critical element of the program is the color code, which consists of three digits, representing red, green, and blue color values. Each digit can vary from 0 to 9 and determines how long a pixel or character will be brightened on the screen. This coding gives 10 intensities for each of the primary colors, which can be combined to create a broad range of subtle hues and shading. For example, pure, brilliant red is represented by the code 900, and a dull, dark red is 100. The code 550 mixes equal quantities of red and green to create yellow, 640 and 730 results in two orange values, and so on.

The first part of the program creates the color picture. Actually, practically any picture-drawing or plotting program can be adapted for color. You need only a pair of subroutines to define a color for each pixel as you draw it. My drawing program sets up a number of drawing statements within an INKEY$ loop. You choose a color, and all parts of the picture drawn subsequently will have that color until a different color is chosen. The three-digit color code in effect remains displayed at the top of the screen.

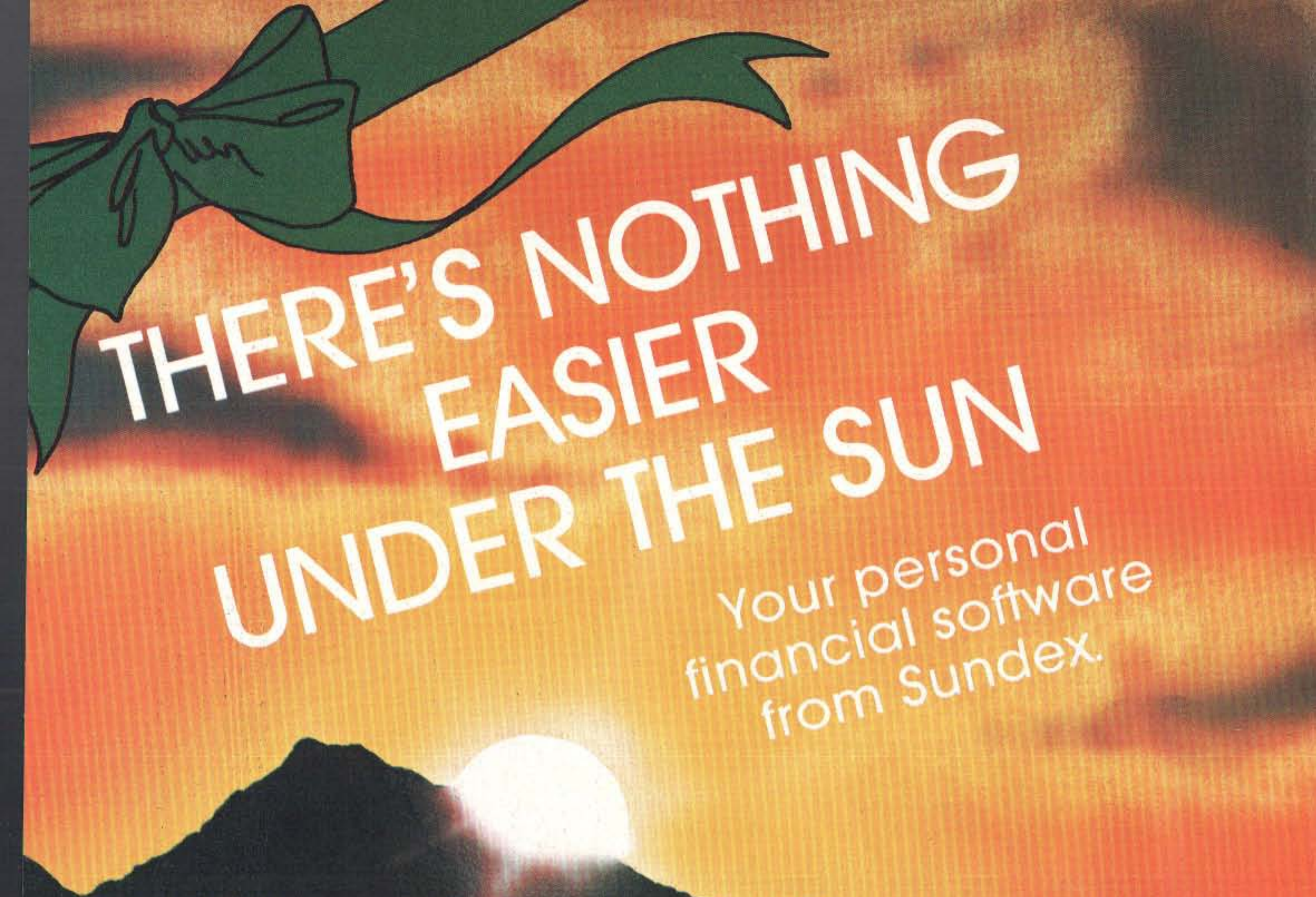
```
10   A$=INKEY$:if LEN(A$)=0
       THEN 10
20 ⎫
30 ⎬  (drawing commands)
40 ⎭
50   IF A$=CHR$(9) THEN
       GOSUB 100:*REM CHR$(9)
       is the TAB key*
100  INPUT "COLOR";KL$:PRINT
       CHR$(30):RETURN
```

The second subroutine saves to memory both the color code and the character code for each point as it is entered:

```
20  Y=INT(A-HOME)/128):X=
      A-HOME-Y*128
30  K$(X,Y)=KL$:L%(X,Y)=T:REM
      *'T' IS THE CHARACTER
      CODE*
40  RETURN
```

(Note: HOME is the memory address of the upper left-hand corner of the video display. When adapting this program for computers other than Osborne, be sure to change the

Circle 405 on inquiry card. ⟶



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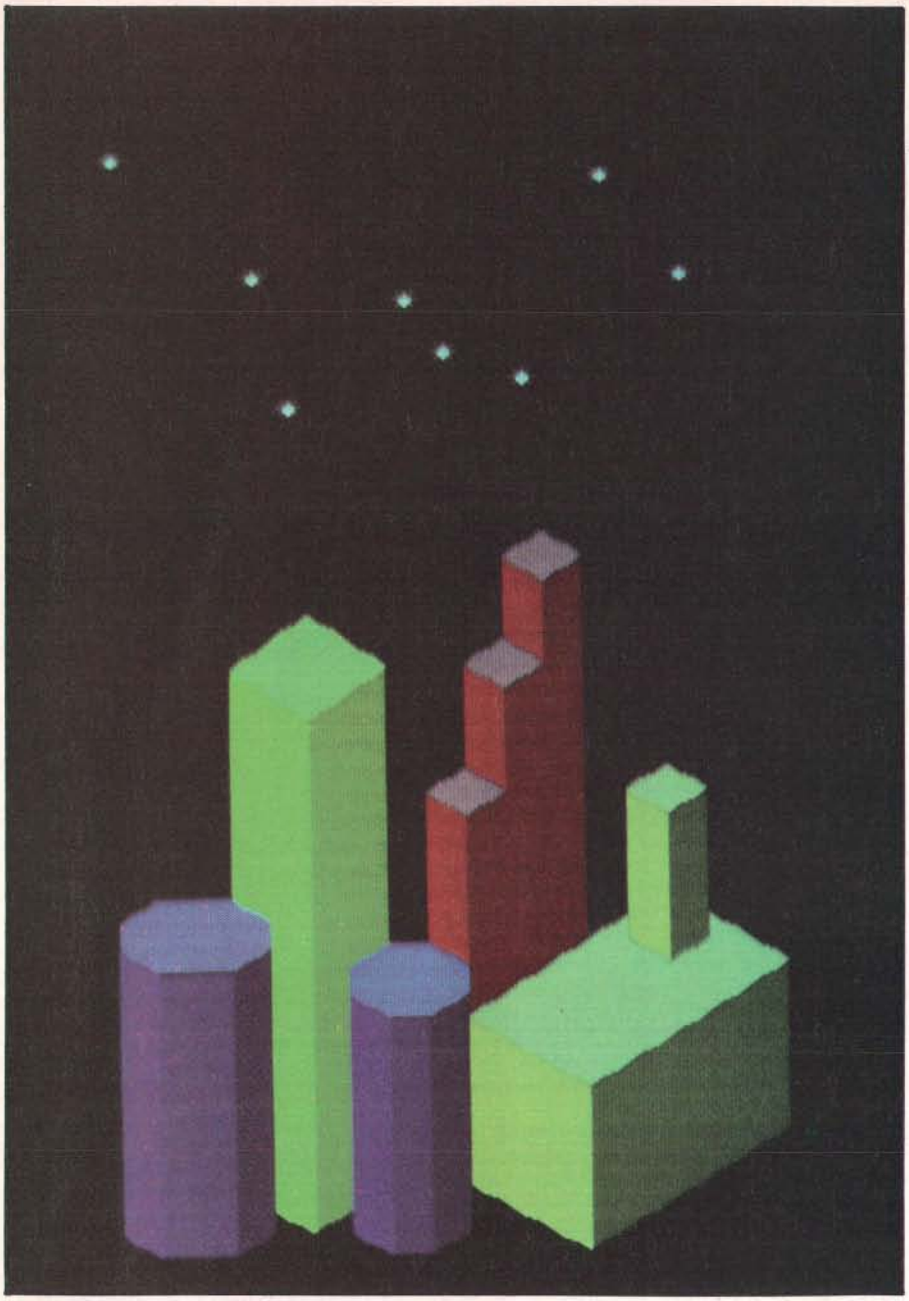

Photo 3: *Low-resolution graphics are not a serious limitation for fine-art applications because of the double-screen mode and shading capabilities. These simulated three-dimensional structures are nothing more than juxtaposed parallelograms and other shapes with varying shades, drawn on alternate screens. Diagonal edges are formed where complementary right triangles on alternate screens share a diagonal series of pixels.*

HOME value in line 80, viewable screen size in line 70, and maximum screen width, 128 on the Osborne, wherever mentioned.)

Once the picture has been created as a dimensioned array, you can save it in a disk file or display it for photographing. To photograph each of the three monochrome screens, first clear the screen and eliminate the cursor.

```
5  PRINT CHR$(26):POKE
       HOME,32
```

Then use the following routine to display the monochrome image for all red values in the picture (the leftmost digit of color code).

```
5    N=HOME
10   FOR Y=0 TO 22: FOR X=0
         TO 51
20   IF VAL(LEFT$(K$(X,Y),1))=0
         THEN 40
30   POKE N, L%(X,Y)
40   N=N+1
50   NEXT X
55   N=N+76: REM *ON THE
         OSBORNE 52-COLUMN
         SCREEN THERE ARE 76
         SPACES FROM THE END
         OF ONE LINE TO THE
         BEGINNING OF THE NEXT
         (52+76=128)*
60   NEXT Y
70   FOR T=1 TO 9
85   N=HOME
80   FOR Y=0 TO 22:
         FOR X=0 TO 51
90   IF T>=VAL(LEFT$(K$(X,Y),1))
         THEN POKE N,32
100  N=N+1:NEXT X
110  N=N+76:NEXT Y
120  NEXT T
```

This routine is then repeated for the green and blue screens. Beginning with line 70, you go through the screen nine times. With the first pass, you delete all characters with red values of 1. On the second pass, you delete all characters with red values of 2, and so on, until the picture is completely blanked out. With this mechanism, you can mix 10 different intensity values within the same screen. Displaying and photographing all three screens in this manner takes 6-7 minutes in MBASIC.

Using Two Screens

When using low-resolution graphics characters, it is sometimes desirable to put two different characters of different colors in the same rectangular pixel. The diagonal edges of the blocks in photos 1 and 3 were done this way, filling each rectangle along the edge with two complementary right triangles of different colors. You must use two separate screens for each color, defining half of each block on one screen and the other half of the block on the other screen, switching back and forth between the screens while drawing the picture. Lettering must be white or a lighter version of the background color because it is "burned in" over the

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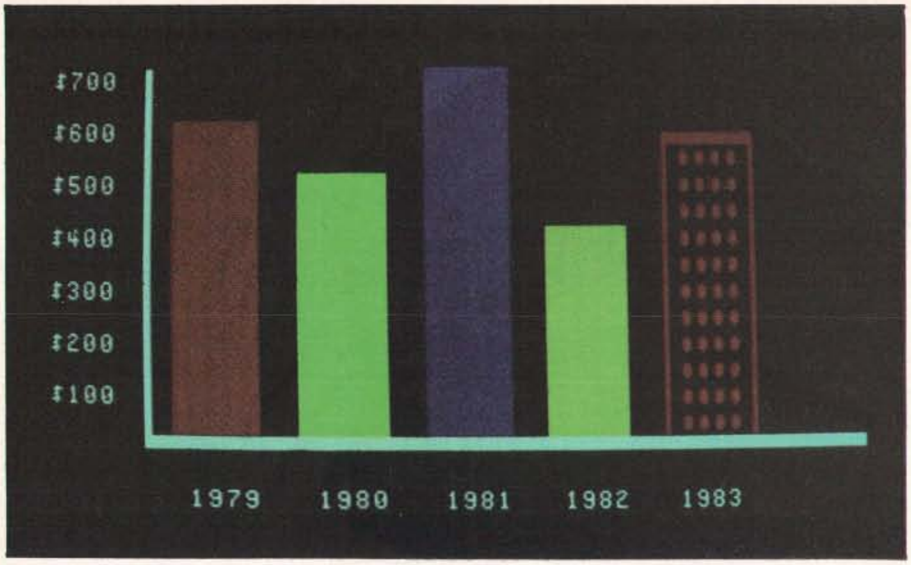

Photo 4: *Snappy color slides for business or educational presentations can be made easily with "black-and-white" business systems and a set of color filters.*

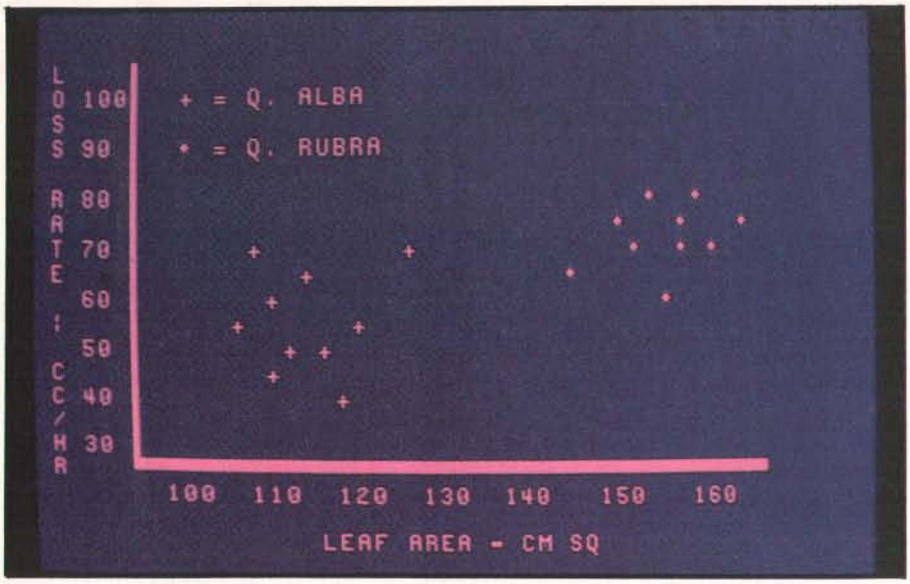

Photo 5: *The popular white-on-blue graphics format usually produced with special film is done easily with a simple double exposure. First, a white screen is photographed through a blue filter, then white graphics on a black background are "burned in" with a second exposure. Any background color can be used with white or lightly colored lettering.*

background (photo 5). Any color of lettering can be used on a black background.

Color Separation with Color Systems

You also can use this separation technique with a standard color computer and color monitor. The editing process is easier because you can see on the monitor the colors you're using. However, the picture you save in memory can contain more color information than the picture you see on your monitor. You have to have two parallel color-selection mechanisms in your program. For example, an area that you color solid red on the monitor might include shading from dark red to light red in the picture being created in memory. You will see the latter only after you've photographed the picture. Be sure to switch to a black-and-white monitor for the photography.

Using High-Resolution Modes

The approach described in this article works fine with the Osborne's low-resolution graphics characters because of the relatively small number of memory locations required. The 52-by-22 display results in 1144 pixels that must be addressed on each screen, and each pixel requires 12 bytes to fully define three colors and character code in the two-screen mode, or about 13K bytes of RAM (random-access read/write memory). Typical high-resolution modes provide for about 320 by 200, or 64,000 pixels. There's no need for character codes or a two-screen mode with high-resolution systems, but 1000-color capability requires 3 bytes per pixel, or about 180K bytes of memory. With a 64K-byte machine like the Osborne, you would have to transfer the picture piecemeal to and from the disk.

The sheer number of pixels that must be selectively turned on and off for each of the three screens would mean a prolonged exposure time (I estimate at least 6-7 hours in MBASIC). Faster 16-bit or 32-bit processors and compiled programming help to reduce this problem. Computers that display a range of gray tones are ideal for this application, as each screen can be displayed and photographed in a few seconds, eliminating the need to scan the picture nine times for different intensity values. For everyone with "old-fashioned" 8-bit, 64K-byte-or-less computers, I suggest starting with low-resolution graphics. Perhaps you might want to take up the challenge of color separation with high-resolution graphics as your proficiency grows.■

Frederick B. Essig holds a Ph.D. in botany. He is an associate professor in the Department of Biology at the University of South Florida, Tampa, FL 33620.

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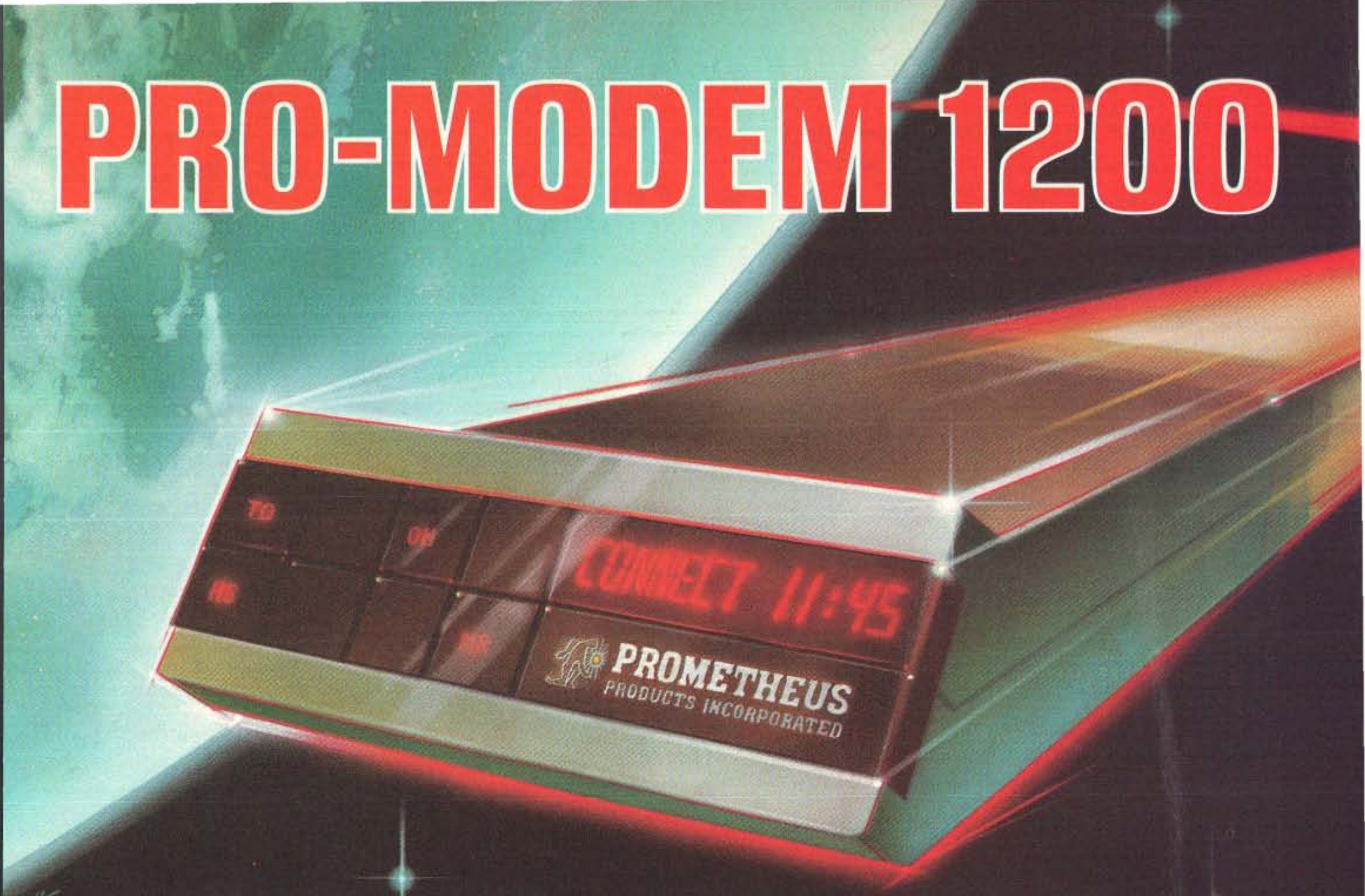

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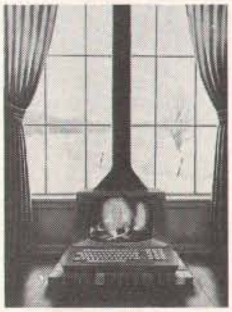
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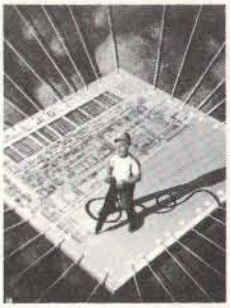
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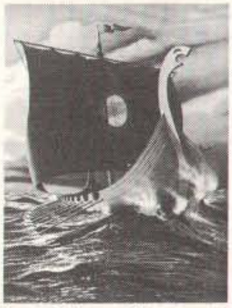
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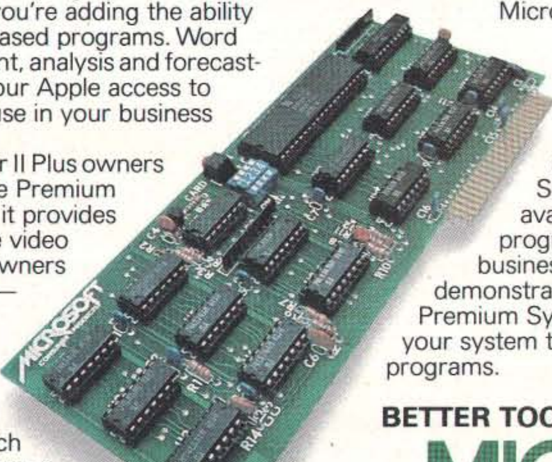

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Mainframe to Micro: Adapting a Financial-Modeling Language

A mainframe software company moving into the microcomputer world must change more than its software

by Greg Dunn

The era of the microcomputer is changing the character of computing. Images of Big Brother and the Pentagon have given way to Matthew Broderick innocently bringing the world to the brink using his home computer in the movie *WarGames*. Gone are the stories of huge programs created by highly trained teams of computer scientists in think tanks, replaced by reports of 20-year-old college dropouts making it big in video games (see the text box "When Worlds Collide: Social Aspects of the Move to Micros'' on page 402).

The success of microcomputers guarantees the attention of big business. Workers having microcomputers at home find it saves them labor in bookkeeping and word processing, provides games for fun and relaxation, and offers educational opportunities in self-paced tutorials on almost every subject. These people soon fit microcomputers into their office budgets. The compelling logic of distributed processing is making the microcomputer an integral part of the computing resource in companies all over the world. And, as the microcomputer moves into the office, software developers face new challenges in translating existing mainframe software to the microcomputer environment.

Issues Affecting the User Directly and the Designer Indirectly

- greatly enhanced visual display capabilities of the microcomputer
- increased "housekeeping" associated with the microcomputer
- limitations of job size
- greatly increased difficulty in obtaining direct product support from the software developer
- data security

Issues Affecting the Designer and Publisher Directly

- product distribution channels
- product support demands
- organizational role, training, and personality profile for the typical user
- piracy

Table 1: *Some issues that distinguish microcomputer software from mainframe software and the groups affected.*

From the Developer's Viewpoint

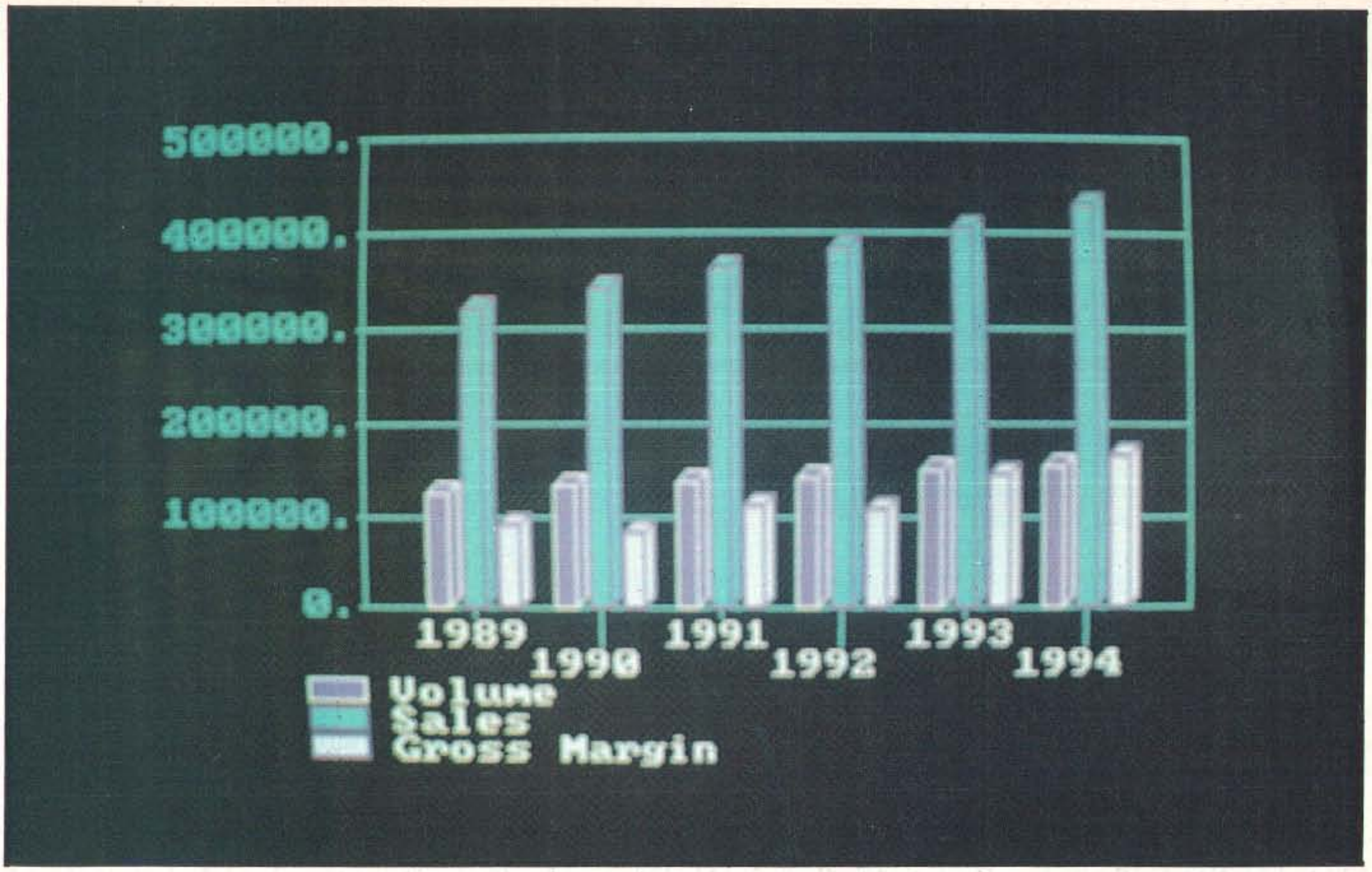
A number of issues distinguish microcomputer software from mainframe software. Some primarily concern the software designer and publisher, while others also concern the user (see table 1). The designer must exploit the special opportunities provided by the microcomputer and minimize any negative consequences of its limitations.

Enhanced Display Capabilities

The mainframe computer's strength lies in its ability to do computations rapidly, to handle large quantities of data, to secure data by means of password protection schemes, and to let many users access a common data library simultaneously. A mainframe's central processor can access large amounts of both directly addressable and peripheral memory rapidly, and it has a data-word size that permits high precision even after repetitive recomputation.

The mainframe's resources permit number crunching on a large scale. However, handling input and output to users becomes a necessary evil, because any resource directed toward that activity steals from the resources used for computations or file access. While this also holds true for a microcomputer, one important difference changes the job of the software developer. The mainframe communicates with a remote CRT (cathode-ray tube) through a transmission line, limited, practically speaking, to a rate of 9600 bps (bits per second). A microcomputer talks to the screen at a memory-write rate of about 4.7 megabytes per second. Whenever the mainframe's central processor is occupied with I/O (input/output) to the user's terminal through this 9600-bps bottleneck, a lot of RAM (random-access read/write memory) as well as hard disks with rapid-access peripheral memory must wait. When the central processor paints menus or pictures on the user's video display, several megabytes stand idle—a high cost for user interface.

Compare this to a microcomputer, where the central processor can write to the screen as fast as it writes to memory and more rapidly than it can



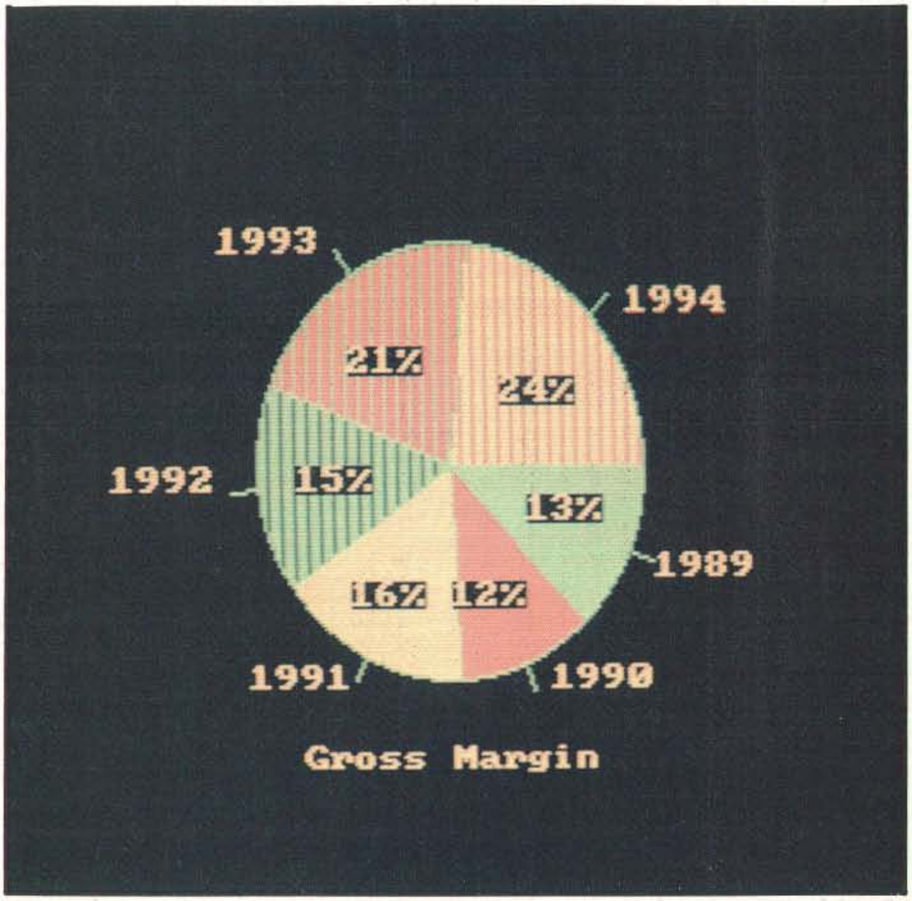
communicate with peripheral memory. Software developers can easily afford to use system resources to support elaborate user interfaces. And those interfaces make a world of difference in who uses the computer, and for what.

Mainframe software typically puts a high premium on abstract, symbolic thought. A user must not only know what he wants but also the command to execute the desired action. Mainframe tools are complex and typically require a substantial time investment for a user to acquire the skills necessary to do serious computation.

On a microcomputer, the programmer makes things easier for the user. Instead of terse symbolic word commands, the user gets "ring" menus or pictures. At any point in the program, users have options displayed on the screen. Even if you use a system only once every six months, you still can do useful work.

The 9600-bps Blues

The microcomputer has enabled us to do things that, while technically



Standard color graphics with the IFPS/Personal package.

feasible on a mainframe, have not been practical because of resource constraints. For example, Execucom Inc. has adapted its mainframe financial-modeling package, Interactive Financial Planning System, or IFPS, to run on microcomputers. Van Van Cleve, a programmer for the IFPS/Personal project, says, "On a mainframe, there is a great disparity in the relative capacities for I/O and computation—and even more between disk-type I/O and user [CRT screen] I/O. On the mainframe you're running to the disk a lot faster than the data rate. As for computations, if you're doing 32 bits instead of 16 bits, you have a great improvement: more than 2-to-1. Bigger words are better for doing crunching operations, but not necessarily for things like strings and characters.

"The best I can get at my video display from a mainframe is a set of codes at 9600 bps. When you start getting more than 9600 bps, the reliability of the transmission line starts to go down. People do 19,200 bps now, but that's pretty special purpose and expensive. It's expensive to run high speed across distance. And you still can't even get close to the speed of communication between the central processor and memory.

"On the microcomputer you have a slow disk and a fast screen: a totally different environment. If we want to talk about [computational-bound] operations and normal I/O, you've got a much slower machine. But when you step into the I/O-intensive world of user interface, you have all the I/O capacity you need. It's not a burden the way it is on the mainframe."

The mainframe is at its best in operations in which the central processor communicates with memory or with the disk, rather than with the CRT. The microcomputer can talk to the screen as rapidly as it talks to memory. The screen is directly memory-mapped. With that method, complete information describing the current state of the screen remains present in memory. Could you design a mainframe that way?

"Yes, you could," says Van Cleve. "The problem is that, if you want to write a mainframe program, you have to know the characteristics of every terminal that will be used to talk to it."

Because it never made sense to design a mainframe to optimize its screen I/O capabilities, the practical limitations of designing complex, screen-intensive user interfaces loom even larger than the theoretical limitations (those resulting directly from the transmission-speed limitations). Appropriate data structures for storing images are not automatically provided in the same way they are in a microcomputer, so they have to be created by the programmers. Says Van Cleve:

"Suppose I want to window a screen in the two systems. If I step into the IBM PC world, I can make a direct call to BIOS [basic input/output system] to scroll. I can scroll quickly to any designated area in the screen I want. If I want to simulate that in the mainframe, yes, I can do it. I can keep a screen image in an array, and I can manipulate it and then flash the results out the data-rate line. But I'm doing a lot of computation, I'm doing a lot of itty-bitty movement, and generating a number of different I/O calls. I can't do this all in one I/O call—fill a buffer full of a lot of things with carriage returns. In a mainframe environment I have to do it in a sequence of I/O calls. I can't control the screen directly. The best I can do is send it a bunch of ASCII [American National Standard Code for Information Interchange] characters that the mainframe then has to interpret in some kind of code to produce something: lines, charts, text, menus, whatever.

"On a microcomputer, on the other hand, you have the memory-map capability—you can write directly to the screen and produce an image at memory-loading speed, which is several orders of magnitude greater than 9600 bps. On a mainframe, I can't read back from my terminal in terms of user I/O. I write something to the screen: *I* have to remember what was there. On a microcomputer you can use the screen as a workspace. You can read back what you've written."

When Worlds Collide: Social Aspects of the Move to Micros

Mainframes and microcomputers have long inhabited separate spheres. When these worlds meet, the people involved in them must make some adjustments. Says Execucom's president, Jerry Wagner, "Mainframe people have a certain style, they have a certain mentality relative to thoroughness of documentation, specifications, all the things that go along with large-systems development. That kind of workstyle doesn't work well in the micro world. At least, it hasn't historically."

Many microcomputer owners take comfort in the thought that their entire system sits on a desk in front of them. For some, it removes feelings of intimidation they've had toward computers; for others, the joy is in the sense of having complete control of the resource. Wade Shaw of Execucom, who comes from a mainframe background, views microcomputers differently:

"I find it uncomfortable to think that the whole thing is sitting right there because I'm used to being on the other end of an organization. In a mainframe environment you have a group of people on the other end that are providing your service, and they buffer some aspects of the computer. To have to go in and put a cable on drives me bananas.

"I don't like to get my hands in the hardware. That's not my job. I've spent my time specializing in software design, and to ask me to actually go in there and change a card—that just blows me away. I feel it's a waste of my training."

Mark Wood at Execucom presents a view that may reconcile some of the differences between microcomputer enthusiasts who love to swap chips and solder connections and mainframe software specialists like Shaw: "It satisfies a basic human need to understand something completely, to form a gestalt of it.

"Look at this terminal that I work on here (which communicates with a remote Prime minicomputer). It has a wire that goes through the wall and when I'm sitting at the terminal I'm working with a tool, part of which is behind that wall. As a casual user, if I don't know about computers, hard disks, communications devices, front ends, packet networks, and whatever else, then there is no way I can

have a complete picture of the tool I'm using. All I know is, here's part of it, and there's something else behind that wall.

"The difference between this kind of user and somebody like Wade Shaw is: he already knows what's on the other end of that wire. He's got a master's degree in computer science. In his mind he has a picture of the complete tool. But for the casual user, it's different. He's using something he doesn't completely understand, and he knows somebody else has control of part of it."

Micro Myths

Developer Shaw talks about some of the myths surrounding microcomputers:

"There are a couple of curious notions surrounding microcomputers. One of them is that microcomputers are going to save the world from the big, bad, expensive mainframes and minicomputers. There's a bit of holiness in there, somehow—that it shouldn't cost that much to do computing, that it's everybody's intrinsic right.

"The other myth is that everybody's going to get rich off of their microcomputer—that every person is a budding computer entrepreneur just waiting to put his or her fingers on the keys and produce a masterpiece that's going to revolutionize the world and make him a millionaire overnight.

"Even though I think there's a lot of bunk in these notions, I enjoy them: at the very least, they're changing the image of programmers. For a long time, programmers have been regarded as clerks, because the first jobs that computers did were to replace clerical jobs. Now, with more people getting involved [in computing], the level of appreciation for what programmers do has been raised."

Microcomputer users' prejudices get into the act, though. Says Shaw, "There's a kind of disgust on the part of some of the younger programmers regarding computing in the mainframe and minicomputer marketplace. Some of the younger programmers make it clear that they really don't want to be involved with mainframes and minicomputers—they're not even curious. It's as though large computers are the past, and mainframe people and corporations aren't going to have any impact on the future. They just don't want to have anything to do with the mainframe world or the past. It's kind of unsettling, because it means they won't benefit from lessons already learned."

Will microcomputers bring computing to the executive's desk? Wagner doesn't think so. "If, say, 5 percent of IFPS [Interactive Financial Planning System] users now are executives, that might increase to 10 percent with the IBM PC, but the number will never be significant. It's not a matter of ease of use, knowing computers, or of MBAs moving into management ranks. It's strictly a matter of time and culture. When you become an executive, it's not a part of the culture to use these kinds of tools.

"The time element closely associates with the cultural factor. To sit down at a terminal and write models, interrogate models, etc., is time-consuming. An executive can use his time much more effectively by working with a staff assistant who will do the model building, the interrogations, and so forth, for him.

"The key here is that the executive must be able to understand the work his assistant does for him on the computer."

Piracy

One software issue that is a much greater problem in the microcomputer market than in the mainframe market is the theft of goods. Software companies commonly estimate that from 25 to 50 percent of their potential revenue slips away to pirates. Why is the problem so much bigger in the microcomputer marketplace? I asked Sam Guckenheimer, Execucom's Product Manager for IFPS/Personal:

"It's harder to track," he said. "The mainframe world is very centralized. Your customer base is made up of a small number of installations and is, by contrast, quite easy to audit. Take a hot-selling machine like the VAX [minicomputer]. There may be 8000 VAXs installed now, something like that. Well, that's a fifth as many processors as IBM PCs are added into the work place every month. It's the difference in magnitude between ships in a harbor and people passing through a subway turnstile. You're talking about much greater dispersion. It's much more difficult to audit and control."

One possible solution Execucom has considered is a combination hardware/software protection scheme, using an encryption algorithm embedded within the software, and the same algorithm burned on a PROM (programmable read-only memory) installed in a device affixed to the keyboard. Other protection alternatives include tying the software to a particular processor by means of a serialized PROM (as Apple has done with its Lisa software) and the method most widely used for lower-priced software in the home market: scrambling the information on the disk.

Of scrambling information, Sam Guckenheimer says: "Well, first, that means you can't copy it for backup. Second, you can't copy it over to a hard disk, and hard disks are starting to get used a lot. And third, it generally means that it takes much longer to boot and it tends to create difficulties in areas like operating-system compatibility. Look at all the software that was released for the IBM PC that doesn't work with MS-DOS 2.0 because protection games were played using memory areas subsequently required by the new operating system."

The protection scheme employing the serialized PROM involves the installation inside the computer of a PROM containing a unique serial number. Software publishers wishing to be protected by that serial number include it in their software, where it is checked against the hardware-resident number before the program will run. Thus a given piece of software is usable on only one machine. Guckenheimer's evaluation: "If you have a multiple-personal computer environment where machines get swapped for service, this solution dies instantly. Also, if people change offices and don't carry their machines with them, this system won't work."

No protection system will please everyone. "Users don't like software protection," Guckenheimer says. "It has, in fact, been recommended by a number of users that we go to multiuser licensing without protection. But then how do we really know how many copies are out there? How do the DP [data processing] departments we deal with know that, for the 100 they've distributed, there haven't been another 500 copies made? Copying a disk is generally a lot easier than getting budget approval."

Changing User Profile

As the character of the computer undergoes a dramatic change with the penetration of micros into the computer resource commonwealth, so does the profile of the typical user.

The new user is maybe someone who previously stayed away from the computer, feeling either that he "wasn't technical enough" to use it or that the investment of time in learning to use it would not be repaid by the benefits of using it. Some of these people have felt, probably correctly, that their need for the machine would be too intermittent to permit them to keep their skills current. The powerful and flexible user interface permitted by the micro-

computer is changing that picture. Says Guckenheimer, "It used to be that the people who worked with computers were always very analytical in their orientation. They would go through long descriptions of problems, meticulously laid out in advance on paper, and then enter them into the computer and solve them.

"Over the past few years software writers have directed more and more attention to making user interfaces flexible. The advent of microcomputers represents a tremendous leap forward in this process, so that now users are developing a different way of behaving with the computer. Instead of laying out their whole problem in advance, they'll sit down and start entering things almost from stream of consciousness. They don't necessarily have a clear definition of their problem when they start; they work it out as they describe it. It does away with, or makes much more cursory, the pencil and paper notes made beforehand. One of the reasons spreadsheets have caught on so well is that they lend themselves to putting in a few random numbers and then experimenting with their relationships until you get something that makes sense.

"I think that because of the microcomputer, there's a general shift in the way jobs are defined. The whole concept of the personal computer as a professional workstation implies that you break down some of the barriers of work specialization and that a given user may employ his computer for a little bit of financial modeling, a little bit of word processing, some graphics, a database, communications, and project management. Before microcomputers, a company had, in the case of financial analysis, a person whose job was financial analysis and nothing else. Now, the capability of doing fairly sophisticated financial analysis is within reach of managers who don't have as much training and don't do financial analysis as extensively. It means that more people will get involved in the process."

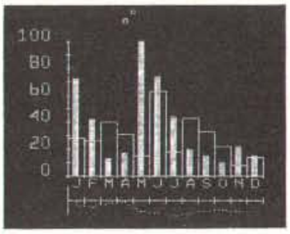
Mainframe software writers have aimed at making user interfaces flexible.

Customer Support

This is another area in which a major transformation must take place in shifting from mainframe to microcomputer. Introductory training delivered at the customer site and telephone hotline support are often included in the price of a mainframe software package, and training on advanced topics is available for a fee. Clearly, this sort of service is not feasible in the microcomputer market, where software is sold in large quantities, through distributors or computer stores, at comparatively low prices. Much of the training delivered in person to clients by mainframe software companies will have to be delivered through the computer for microcomputer software.

Product documentation must be thorough and understandable if a microcomputer product distributed through extremely high-volume channels is to stand on its own. If documentation is to become more helpful to the user, it will have to do

Business Scientific Data Plotting



Softkit # 2

Data Plotting Software for Micros- This 232 pg book/disk package contains 18 programs in BASIC for processing and plotting data: Histograms, pie charts, log plots, regression, statistical analysis, curve fitting, barcharts, stock market charts, 3D views of surfaces, data management, applications to science, engineering and business.

Special features include writing text over graphics, automatic scaling and axis labeling, automatic replotting when data is changed.

Book contains program listing in Applesoft BASIC with theory, equations and full documentation. Disks contain same programs in Applesoft BASIC or IBMpc BASICA. Use the programs as-is or modify and combine for your own special applications.

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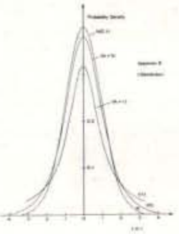
Applied Statistics for Micros



Softkit # 7

Applied Statistics for Micros- This is a package of professional level statistics programs for use in business, science and engineering. Book contains program listings in BASIC alongside theory and documentation. Optional disk contains same programs in BASIC.

Book gives clear, easy-to-read tutorial on errors, statistical distributions, hypothesis tests, variance, covariance, regression, response surfaces and time series. 22 programs calculate normal, chi-square, t and F distributions; variance with randomized blocks, Latin squares, factorials, response surfaces. Hi-accuracy multi-linear regression program has data handling and transformation. Also programs for hypothesis testing, sorting and smoothing. Numerous practical applications.

Assumes no prior knowledge of statistics. Used as a text for years at a leading university.

Please send: ☐**Book- $38**
☐**IBMpc BASICA Disk- $26** ☐**Applesoft Disk- $26** ☐**CP/M86 Disk- $26**

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so by being integrated as directly as possible within the product. As Guckenheimer says, "The concept of printed documentation is limiting. Documentation includes user prompts, help messages, interactive tutorials, and what-have-you. All of those tie together.

"Documentation is important, but it's often misunderstood. The most effective documentation is that which has to be read least. People often think of documentation as being effective when one can get a full description of what the software does from it. It's much better if the software explains itself."

What You Learn from a Mainframe Background

Kirk Jones explains why he thinks a company like Execucom, with a background in mainframe software development for large corporations, has an advantage in the big business market, even over companies with more experience in microcomputer software.

"We've learned from 10 years of experience how people solve corporate problems and what the information systems requirements are for solving corporate problems. We've learned how people integrate systems and models together, and what kind of support they have to have to solve corporate problems.

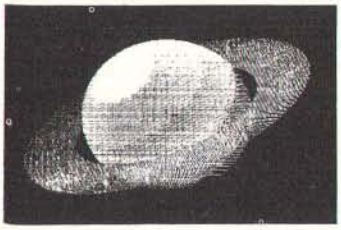
"What Visicorp knows how to do extremely well is solve the individual's business problems. But one of the problems with a Visicalc-like product is the difficulty of maintaining the model. It is relatively tough to write a Visicalc model this month, not use it for six months, and then take that same application and run it again successfully, with new numbers, and still know what the numbers mean. Many Visicalc users find it easier to rewrite their spreadsheet after six months than to try to update the old one. One of the things we've learned with IFPS is that maintainability is extremely important from a corporate point of view. The corporation can't afford to pay for that rebuilding."

Maintainability is extremely important from a corporate point of view.

Gary Greenfield, head of development for IFPS/Personal, concludes, "I think we're going to see a merging of what the mainframe software marketplace and the microcomputer marketplace have meant to their users. From the micro software marketplace, I think we will take lessons concerning the supportive user interface and the type of documentation and outline tutorials that users want. With microcomputer software relatively inexpensive compared to what we've been used to in the past, we've got to take a look at more cost-effective means of distributing our product: not just the software package, but the services associated with it, too.

"On the other hand, I think we can teach the microcomputer industry something about the type of professional training, consulting, and hotline service that corporate customers want from software vendors. We're going to see these marketplaces coming together."

Graphics for the IBMpc Apple II



Softkits # 5,6

This is a spectacular collection of graphics programs for the IBMpc and the Apple II or IIe. It contains more than 60 programs in BASICA. They're listed beside theory and equations in a 280 page self-teaching guide. An optional program disk is available.

These programs will show you how to write your own 2D and 3D graphics software and they will give you many useful, ready-to-run graphics routines to incorporate in your own software.

Programs are menu driven and modular. They show how to use elementary graphics commands and do 2D and 3D translation, rotation, scaling, clipping, windowing, hidden line removal, shading, perspective, hi-speed animation, with applications to science, business, engineering and games.

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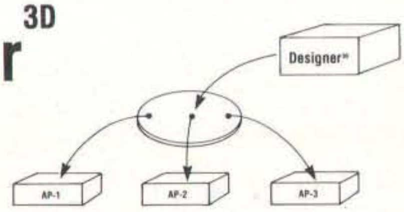
Designer^{3D}



Softkit # 8

This is a professional 3 dimensional graphics design program. With Designer^{3D} you can interactively create 3D drawings on the screen, rotate in 3 dimensions, enlarge, view in perspective, store on disk, recall and update.

Run Designer^{3D}- a cursor appears on the screen with a set of 3 dimensional coordinate axes. Move the cursor around in 3 dimensions identifying node points, lines and points defining curves. Curves fit through points using a cubic spline algorithm. See your 3D picture being created on the screen. X,y,z coordinates are displayed as the cursor moves. Then enlarge, rotate, store your 3D picture on disk, recall and modify.

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Housekeeping Problems

Kirk Jones worked only on mainframes before his assignment to Execucom's IFPS/Personal project. He makes this observation about microcomputers: "Personal computers are very unfriendly in the demands they make on the users for file backup and maintenance (*source management*, in traditional data-processing terms). They've put many of the problems that the mainframe world solved 20 years ago back in the user's lap. He is now responsible for backing up his floppy disks and for figuring out what to do when one of them goes bad. It's the user's problem when the disk can't be read, whereas in the mainframe world that is taken care of for you. There are people who do nothing but insulate the user from the hardware environment and the operating-system environment."

The same sort of phenomenon affects the software developer in a different way. Wade Shaw, a computer-language designer for Execucom, had these comments:

"One of the biggest problems that we've encountered with microcomputers has been control of the software source. You've written a program, you've fixed it up and think it's correct, and now you want to put it somewhere. So you put it on a floppy disk. Floppy disks tend to be somewhat unreliable, so you back it up on another floppy disk. Later, you make some changes in your master floppy disk. When somebody wants the program, you may hand him the wrong floppy disk.

"Or maybe you put the floppy disk onto the central system, the archival source system. Somebody takes that copy off, works on it, makes some changes to it, and doesn't tell you. Now you come back in, make some changes, and you overwrite his copy on the master. Pretty soon people start finding bugs they've already fixed, or they have to reenter enhancements they've already completed.

"Of course, this is always a problem when you have a lot of people working together, and it can be alleviated to a certain extent by careful planning and control of the source. But the problem is aggravated by having a distributed computing facility as opposed to a centralized one."

Choices for Software Vendors

What microcomputer limitations have to be sidestepped or overcome to adapt software originally designed for a mainframe? Three important ones are utilization of memory, access time to the disk, and the speed of execution of floating-point arithmetic.

The first two limitations are almost inseparable, given the close functional resemblance of direct-access (RAM) and peripheral memory (floppy disk, RAM disk, or hard disk). An overlay structure, wherein sections of a program are swapped in and out of direct-access memory from disk as needed, allows the successful execution of a program too large to fit in RAM. Using this scheme, the programmer frees himself to write a program as large as he thinks his user has peripheral memory to accommodate. He is, however, subject to the constraint that no legal command given by the user ever requires a larger portion of the total program than will fit in the available RAM. He must also incorporate in his design the logic that decides what sections of the total code should be in RAM following a given user command.

What makes the overlay solution less than glorious are the delays the user must endure while waiting for code to be read in from the disk. How much time does he spend waiting? It depends on how fast new information can be obtained from the disk, how many distinct overlays have been built into the program (and therefore how often disk reads are required), and when the overlays must be swapped out during user interaction.

In practice, the second factor depends on the first, since the programmer must take it into account in designing his system.

The amount of time a user spends waiting depends mainly upon the technology available. Floppy-disk storage is slower but cheaper than hard-disk storage; hard-disk storage is slower but cheaper on a per-byte basis than RAM disk or direct-access

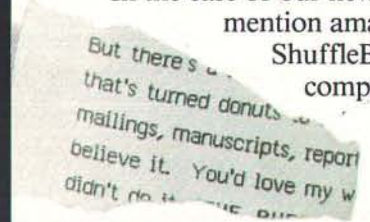
THE BUFFER DID IT.

Who Stole The 1500 Letters From The Computer?

Let's just say you've got to send a letter to 1500 different people. Would you like to spend 22.5 hours* or 60 seconds of computer time?

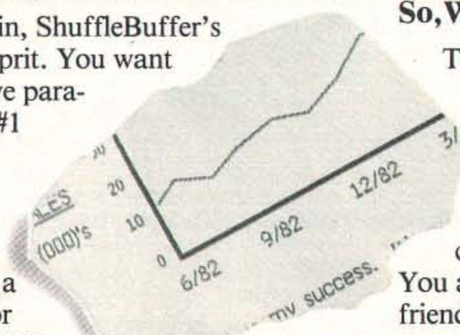
With a garden-variety buffer, the computer has to mix, merge and send 1500 addresses and 1500 letters to the buffer. Trouble is, most buffers only store about 32 letters. So after 32 letters, the computer's down until the printer's done. Altogether, you're talking 22.5 hours.

In the case of our new (not to mention amazing) ShuffleBuffer, computer time is 60 seconds flat. Just give ShuffleBuffer one form letter and your address list, and it takes care of the mixing, the merging, and the printing. But that's not all ShuffleBuffer's stolen from the computer. Oh, no.



Who Changed and Rearranged The Facts?

Again, ShuffleBuffer's the culprit. You want to move paragraph #1 down where #3 is? Want to add a chart or picture? No problem. No mystery, either. Any buffer can give you FIFO, basic first-in, first-out printing. And some buffers offer By-Pass; the ability to interrupt long jobs for short ones. But only ShuffleBuffer has what we call Random Access Printing — the brains to move stored information around on its way to the printer. Something only a computer could do before. Comes in especially handy if you do lots of printing. Or lengthy manuscripts. Or voluminous green and white spread sheets. And by the way, ShuffleBuffer does store up to 128K of information and gives you a By-Pass mode, too.



And Who Spilled The Beans 239 Times?

Most buffers can't tell the printer to duplicate. If they can, they only offer a start/stop switch, which means you're the one who has to count to 239. Turn your back on your buffer, and your printer might shoot out a room full of copies. ShuffleBuffer, however, *does* control quantity. Tell it the amount, and it counts the copies. By itself.

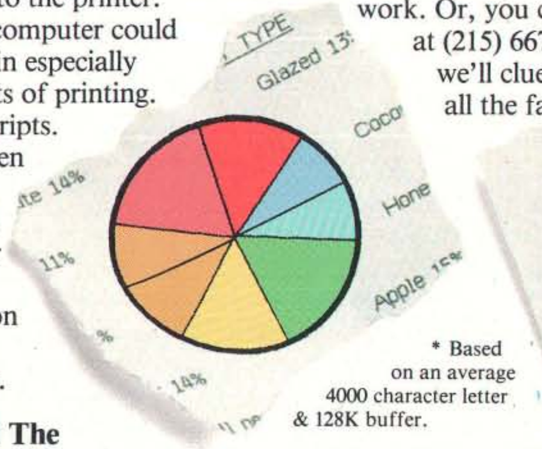
So, What's The Catch?

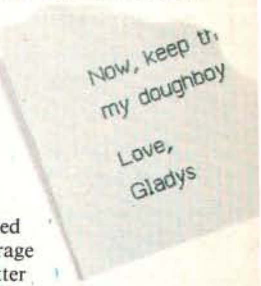
There isn't any. Sleuth around. You won't find another buffer that's as slick a character as this one. You also won't find one that's friendly with any parallel or serial computer/printer combination. This is the world's only universal buffer.

With a brain.

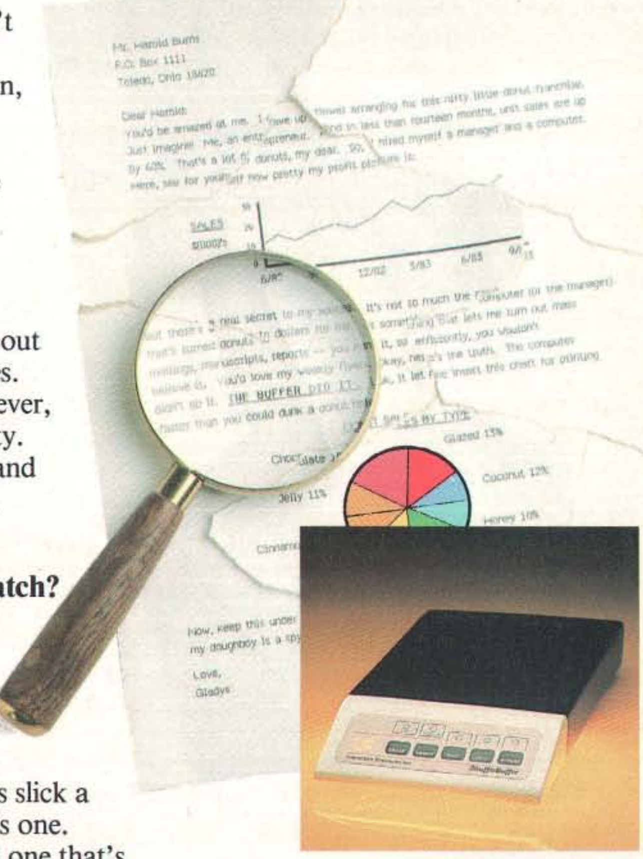
Who Wants You To Catch A ShuffleBuffer In Action?

You guessed it. We do. Just go to your local computer dealer and ask him to show you a ShuffleBuffer at work. Or, you can call us at (215) 667-1713, and we'll clue you in on all the facts directly.





* Based on an average 4000 character letter & 128K buffer.



ShuffleBuffer

The Buffer with a Brain

Interactive Structures Inc.
146 Montgomery Avenue
Bala Cynwyd, PA 19004

memory mounted directly on the computer's motherboard. Therefore, like any other designer, the programmer must make some decisions about what equipment he thinks the user will be able and willing to obtain.

Shaw thinks that, above a certain reasonable minimum, the amount of memory available to the user is not necessarily the key factor in determining his ability to get the assistance he needs from the computer. "The problem with models is that they can always get bigger than your memory no matter how much you have. Even if you could buy an unlimited amount of memory, you'd still have a problem, because at some point your model is going to reach a size and complexity you can't work with effectively. I think that eventually the business analysts who do modeling will have to learn some of the same lessons programmers have, about structured design and modularization of models, the cost of maintaining code, and the importance of documenting it well."

The IFPS Example

As mentioned previously, Execucom markets a simulation-modeling language known as IFPS designed to run on a mainframe.

The company recently released IFPS/Personal, a smaller version of the mainframe package for the IBM PC and related microcomputers. Available initially only to corporate customers owning the mainframe package (with which IFPS/Personal communicates), the stand-alone microcomputer system will be released for the mass-distribution market early in 1984.

The Mainframe System

IFPS is an ultra-high-level simulation-modeling language. It runs on computers from the Wang VS series to the largest IBM and Cyber machines and on more than 25 different operating systems.

The modeling language itself is nonprocedural and English-like. The term "ultra-high-level" distinguishes it from high-level languages such as COBOL, FORTRAN, and Pascal because IFPS is as far beyond these languages on the machine-language-to-spoken-word continuum as they are from assembly language. Users may order model statements almost arbitrarily, without regard to required computational sequence, as shown in listing 1. Internally, IFPS reorders statements so that no variable is computed before others on which it depends. The exception occurs when model statements describe a simultaneous equation. When this occurs, IFPS automatically employs an iterative numerical method to obtain the correct solution.

Interrogation facilities of the language include What If, Goal Seeking, Analyze, Sensitivity, and Impact. Most readers have some concept of a What If capability because some form of it is a feature of nearly every electronic spreadsheet on the market. In IFPS, What If is literally "what if" (see listing 2). In contrast to What Ifs in most spreadsheet packages, a What If in IFPS leaves the base case unaltered, so a user can do any num-

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Listing 1: *A model written for mainframe IFPS. The model statements may be ordered almost arbitrarily.*

```
MODEL PRODBUD  VERSION OF  07/14/83  15:43
100 COLUMNS 1-8
110 * QUARTERLY PRODUCTION BUDGET
120 *
130 *    INVENTORY REQUIREMENTS
140 UNIT SALES = 200,350,350,500,500,400,450,400
150 BEGIN INV FINISHED GOODS = 200, PREVIOUS ENDING INV FINISHED GOODS
160 DESIRED END INV FINISHED GOODS = 30% * FUTURE UNIT SALES FOR 7, '
170                     PREVIOUS
180 *
190 UNIT PRODUCTION = UNIT SALES + DESIRED END INV FINISHED GOODS - '
200         BEGIN INV FINISHED GOODS
210 *
220 ENDING INV FINISHED GOODS = BEGIN INV FINISHED GOODS + '
230         UNIT PRODUCTION - UNIT SALES
240 *
250 *    MATERIAL REQUIREMENTS
260 COST OF MICRO CHIP BOARD = 200
270 COST OF CHASSIS PARTS = 60 FOR 4, 65
280 COST OF TERMINAL CHASSIS = 220
290 *
300 TOTAL COST MICRO CHIP BOARDS = COST OF MICRO CHIP BOARD * UNIT PRODUCTION
310 TOTAL COST CHASSIS PARTS = COST OF CHASSIS PARTS * UNIT PRODUCTION
320 TOTAL COST TERMINAL CHASSIS = COST OF TERMINAL CHASSIS * UNIT PRODUCTION
330 *
340 TOTAL COST MINICOMPUTER = SUM(TOTAL COST MICRO CHIP BOARDS THRU
     TOTAL COST TERMINAL CHASSIS)
350 *
360 *    LABOR REQUIREMENTS
370 TOTAL LABOR HOURS = LABOR HOURS PER UNIT * UNIT PRODUCTION
380 LABOR HOURS PER UNIT = 100
390 AVG LABOR RATE = 9.50 FOR 2, 10.80 FOR 3, 11.00
400 *
410 DIRECT LABOR = TOTAL LABOR HOURS * AVG LABOR RATE
```

Listing 2: *The IFPS What If and Goal Seeking interrogation facilities.*

```
INPUT: MODEL PRODBUD
READY FOR EDIT, LAST LINE IS 410
INPUT: SOLVE
ENTER SOLVE OPTIONS
INPUT: L340


***** WHAT IF CASE 1 *****
1 WHAT IF STATEMENT PROCESSED

                      1      2      3      4      5      6      7      8

TOTAL COST MINIC  50400 168000 189600 240000 227950 201275 210975 194000

ENTER SOLVE OPTIONS
INPUT: GOAL SEEKING
GOAL SEEKING CASE 1
ENTER NAME OF VARIABLE(S) TO BE ADJUSTED TO ACHIEVE PERFORMANCE
INPUT: COST OF MICRO CHIP BOARD(1)
ENTER 1 COMPUTATIONAL STATEMENT(S) FOR PERFORMANCE
INPUT: TOTAL COST MINICOMPUTER(1)=54000


***** WHAT IF CASE 3 *****
1 WHAT IF STATEMENT PROCESSED


***** GOAL SEEKING CASE 1 *****

                      1      2      3      4      5      6      7      8

COST OF MICRO CH  234.3    250    250    250    250    250    250    250
```

ber of tentative explorations without getting lost.

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tion it may be clear that a higher production volume is needed, so the user can begin exploring the ramifications of the new production volume, using What If.

Analyze provides a stepwise trace back through model logic to help the user determine dependency relationships among model variables. Sensitivity determines the relative sensitivity in a given variable's values to changes in the values of other model variables. Impact performs the inverse process of clarifying what effect changing a given variable's values will have on any other model variables specified by the user.

IFPS incorporates a command language enabling users to construct turnkey systems that can process millions of bits of data through a series of complex operations upon the receipt of a single command. A Universal Consolidation subsystem allows the consolidated solution of models representing any number of individual entities (e.g., profit centers) at any number of organizational levels.

Mainframe IFPS offers sophisticated reporting facilities and provision for the two- and three-dimensional data files. It supports the storage of models and data files in compiled (binary) form and allows data encryption for security.

For special-purpose applications, mainframe IFPS is extensible, permitting users to link into the package their own FORTRAN functions and subroutines. Once linked, these routines may be called to operate upon model data as if they were intrinsic facilities of the language.

The maximum size of models in IFPS generally depends only upon the amount of memory a user has on his machine. Models as large as 8000 variables have been run. A typical IBM site running IFPS under the TSO time-sharing administrator reserves a full megabyte of virtual memory per normal user. Users running exceptionally large models are allocated more space.

Internally, mainframe IFPS is a combination FORTRAN/assembly-language program tens of thousands of lines long. To accommodate the variations in local FORTRAN among its many different environments, IFPS's master source contains about twice as many FORTRAN lines as actually get shipped as the system for any given machine. It also contains routines in 12 different varieties of assembly language. To create a system for a given machine, Execucom's installation crew runs a code-selector program against that massive source, which throws out everything but the code directly relevant to the machine being addressed.

Over the years, falling prices for memory and the concomitant rise in its availability at a given customer site have allowed IFPS to evolve in two important directions. First, it has become more powerful through the addition of new features and the extension of existing ones. Second, it has become easier to use through the concentration of greater resources into the user interface.

Companion packages extend IFPS's capabilities in many directions. IFPS/Graphics provides full-color high-resolution graphics generation capabilities, including three-dimensional graphics, stackable bar charts, exploded pie charts, and all traditional forms of business graphics. IFPS/Dataspan provides for the conversion of reports produced by non-IFPS systems (such as databases and statistical-analysis packages) into datafiles suitable for use with IFPS. IFPS/Sentry provides for the creation of online "interviewers" who guide data-entry sessions by conversationally prompting the user for needed data. Entered data is checked against predefined specifications to minimize errors. IFPS/Optimum permits the solution of optimization problems formulated in the standard IFPS modeling language. The solution of integer, linear, and nonlinear problems is supported.

Several more interfaces are under development.

IFPS/Personal

The microcomputer version of IFPS, called IFPS/Personal, represents both a subset and a superset of the mainframe package. While it cannot handle models as large or computations as complex as its mainframe counterpart, it retains the nonprocedural, English-like syntax. Like the mainframe system, it is a general-purpose simulation language not restricted to financial applications. IFPS/Personal runs on the IBM PC and compatibles, the Compaq, the TI Professional, and the Computer Device Dot. Execucom plans to extend its availability to all major microcomputers running MS-DOS.

For the microcomputer user interested in IFPS/Personal, an important question is: how much of this mainframe power can be packed into a $4000 desktop computer?

In one sense, the answer is: all of it. Through a LINK command, users of IFPS/Personal can send models and other entities created on the PC to their mainframe for processing by mainframe IFPS or any of its companion products. Users can also have results shipped in the reverse direction. To perform operations available only on the mainframe, they can turn their PC into a remote terminal with the command HOST. This direct link between the microcomputer and mainframe versions of IFPS provides the user with the choice of a technology appropriate for his task. He can, for example, create and edit all of his models on his PC. Editing may account for fully half of the computer time logged by financial planners. This computer time will now cost essentially nothing beyond the relatively small cost of the microcomputer itself.

The IFPS/Personal user will be able to solve all but very large models directly on his personal computer, and he will be able to do most or all of his reporting and graphics. Only the tasks that require the power of the mainframe (such as the consolidation of giant, integrated modeling systems involving very large amounts of data) need be performed on a mainframe.

Although IFPS/Personal lacks some of the facilities of the mainframe version, it has some significant features its mainframe counterpart does not. In most cases these enhancements are suggested by and depend upon the unique hardware/operating sys-

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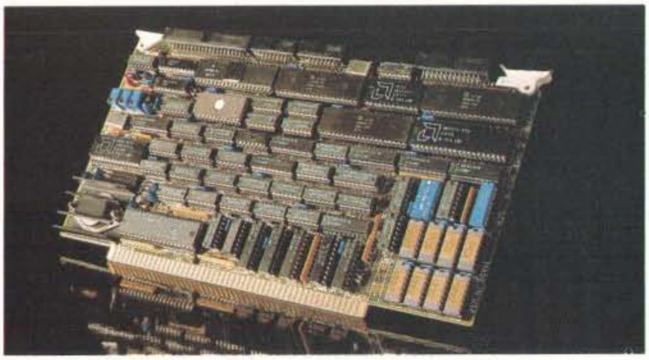

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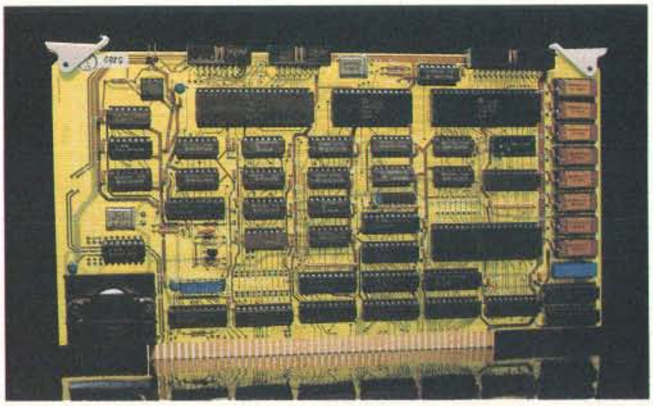

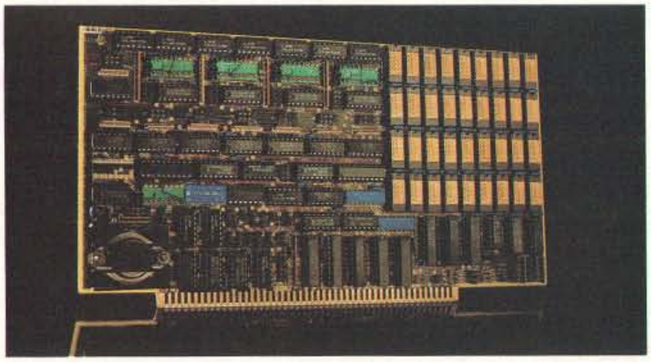

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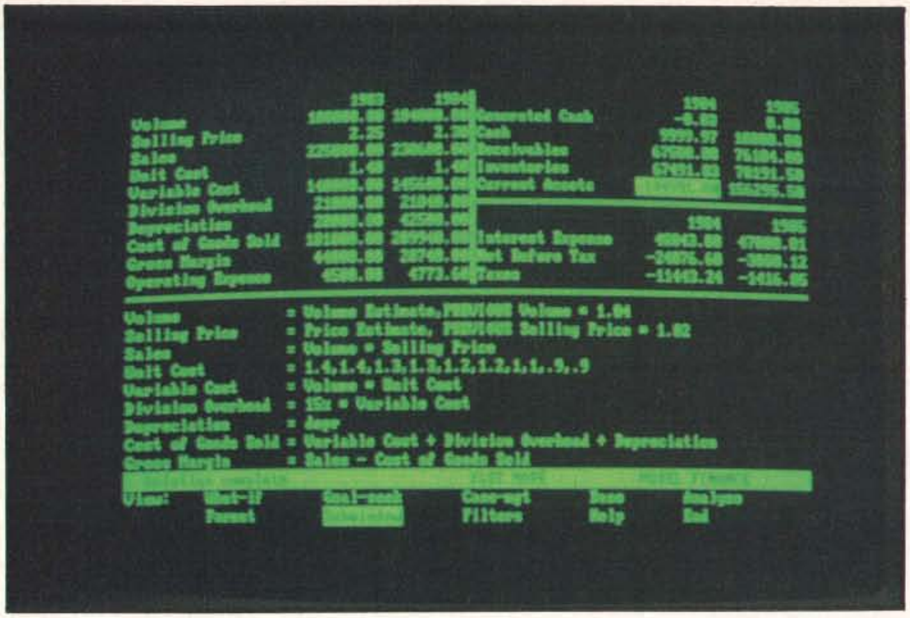

```
Volume              = Volume Estimate,PREVIOUS Volume * 1.04
Selling Price       = Price Estimate, PREVIOUS Selling Price * 1.02
Sales               = Volume * Selling Price
Unit Cost           = 1.4,1.4,1.3,1.3,1.2,1.2,1,1,.9,.9
Variable Cost       = Volume * Unit Cost
Division Overhead   = 15% * Variable Cost
Depreciation        = Depr
Cost of Goods Sold  = Variable Cost + Division Overhead + Depreciation
Gross Margin        = Sales - Cost of Goods Sold
```

Photo 1: *Ring-menu choices are displayed at the bottom of the screen.*

tem facilities of the microcomputer environment.

Enhancements in IFPS/Personal

Ring-menu choices (see photo 1) replace typed commands throughout IFPS/Personal. Thus the user always has in view all or almost all of the currently available options. He need not search his memory or manual for the appropriate command word. Tapping the keyboard's space bar moves the user between choices: he uses the Enter key to select one. Single-stroke keyboard commands are also supported so that, as the user becomes familiar with the system through repeated use, the system can keep up with him.

A View mode gives Personal the capabilities of a spreadsheet package, including multiple windows and individually formattable columns. In addition, IFPS/Personal is a complete simulation-modeling language, providing model logic on the same screen with the spreadsheet-like solution matrix.

A full-screen editor supplants the line-oriented editor of the mainframe version. Facilities include block moves of text and several forms of an UNDO command. Color graphics are standard (see photos on page 401), as are user-definable function keys.

Like the mainframe version, IFPS/Personal supports many forms of model interrogation, nonprocedural modeling, use of datafiles, automatic solution of simultaneous equations, sophisticated reporting, command files, and recording of terminal sessions. It is even possible to create a command file automatically, simply by giving a command to record input and stepping through the desired operations.

What Got Left Out?

As a stand-alone package, IFPS/Personal lacks the following capabilities of mainframe IFPS:

- It cannot perform the complex, multimodel consolidation supported by the Universal Consolidation facility of mainframe IFPS that commonly supports applications involving more data than can be readily processed within the resources of a microcomputer.
- It has no capability for interfacing user-defined routines.
- It has links to the extension products Sentry, Dataspan, and Optimum and to external packages only through mainframe IFPS.
- Its command-file facilities are less powerful than those in the mainframe system.
- Binary storage of datafiles and models and data encryption are not supported.
- It cannot process models as large as those that mainframe IFPS can handle.
- It is computationally slower.

As memory and fast peripheral storage for microcomputers continue to become cheaper, many of these mainframe capabilities will be included in the microcomputer package.

So Who Needs Mainframes, Anyway?

According to Kirk Jones, who wrote the specifications for IFPS/Personal, a mainframe's strength "lies in its speed of computation, power in data management, and in the data security it can provide."

The mainframe computer is ideally suited as a central repository for large amounts of data. Because everything is in one place, security is easier to provide, at least from the point of view of the person with the master password to the machine. And, as Execucom's Competitive Analyst Mark Wood points out, "Even with the most powerful of today's micros, the 32-bit machines, it is still possible to formulate models and programs that only a mainframe can solve in a reasonable amount of time."

I asked Sam Guckenheimer, the IFPS/Personal Product Manager, what people who have IFPS in both versions would continue to do on the mainframe.

"They'll keep their corporate databases and model libraries there. Also, they'll do their big consolidation solutions there. Where you have geographic dispersion—in other words, where you have several offices accessing the same database—the mainframe is where you put all the components together. It is becoming a data library."■

Gregory T. Dunn is a User Documentation Consultant at Execucom Systems Corp. He can be reached at 2513 Mountain View Dr., Austin, TX 78704.

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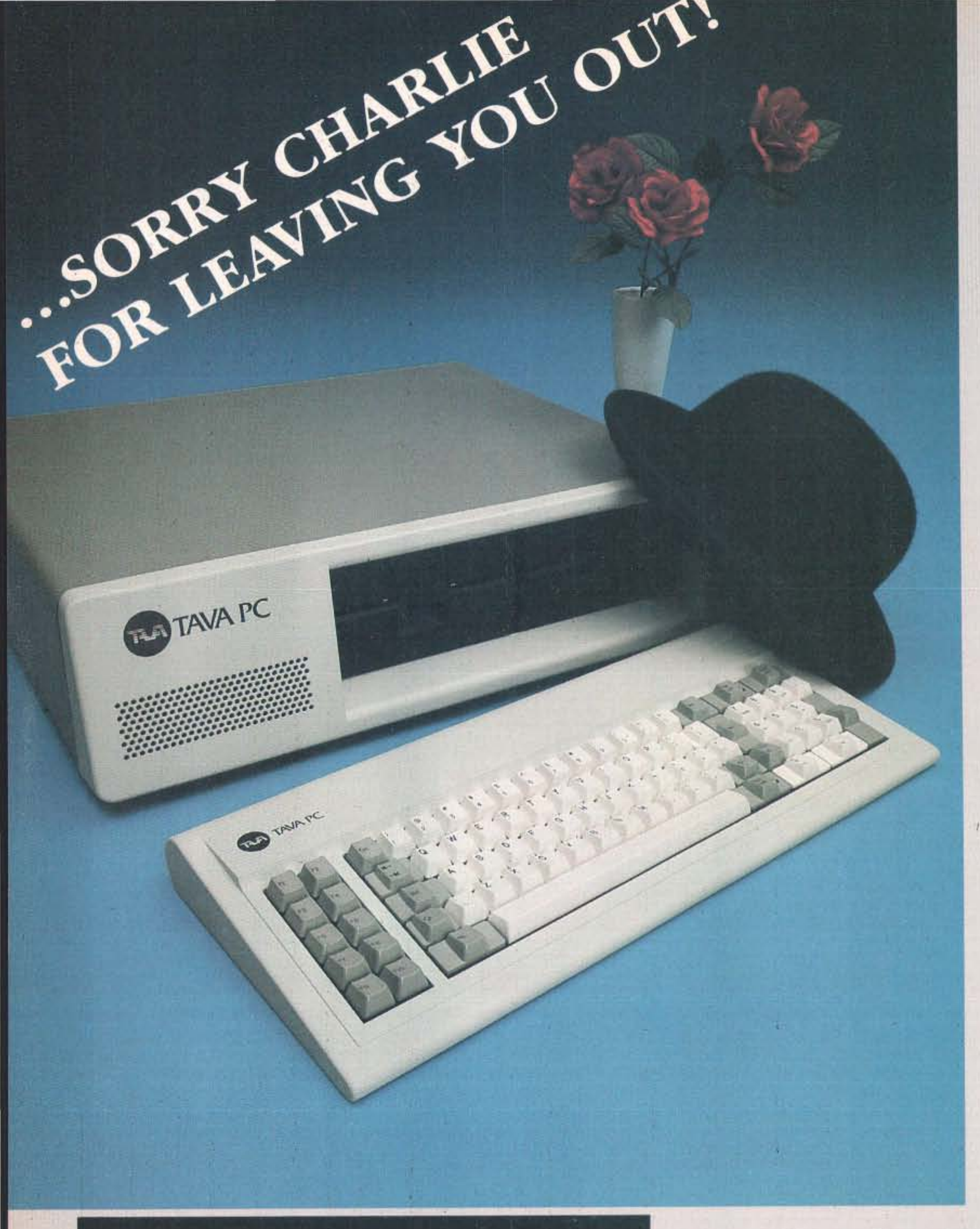

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POKEing Around in the IBM PC

Part 2: Developing subroutines for BIOS interface and screen-display disk storage

by Hugh R. Howson

Part 1 of this two-part series introduced the concept of accessing the IBM Personal Computer's (PC's) BIOS (basic input/output system) from a BASIC program and summarized the PC's BIOS functions and central processor registers. Building on this background, this concluding part develops a general-purpose BIOS-interface subroutine that can transfer parameters from a BASIC program to the BIOS and can store BIOS results in memory. Then a subroutine is presented that can move data from one memory location to another using a machine-language MOV instruction. Finally, this article describes a subroutine that can store screen data on a disk. This second subroutine provides the file-handling facilities of DOS while avoiding the standard BASIC commands that can be cumbersome for operations involving large quantities of data.

A BIOS Interface Subroutine

We'll use the same approach in developing the general-purpose BIOS-interface subroutine that we used to develop the screen-scroll subroutine in Part 1. That is, at the sacrifice of some programming elegance, I use the simplest conceptual approach to get a working program, relying as before on direct moves from the program to the registers. In addition, this general-purpose subroutine must be able to store results from registers into memory.

The first action of the subroutine is to store the current contents of the segment registers on a stack so that they can be restored at the end of the program. This step ensures that when control is returned to the BASIC program, that program can continue from the state it was in prior to the subroutine call. We did not need this step in the Part 1 program because that specific subroutine would not affect these register values. This general-purpose program, however, requires such a safeguard.

The operation codes that store these register values are each 1 byte, as listed below:

55	(BP register)
1E	(DS register)
16	(SS register)
06	(ES register)

(Note that unless otherwise specified, all addresses and numerical instructions are given in hexadecimal.)

The effect of each of these instructions is to decrease the value of the stack pointer (SP) and then store the register value in the memory location pointed at by the SP. The SP normally points to the last item pushed onto the stack, which is referred to as the top of the stack.

Next, we provide for storing a segment address in the extra segment register (ES) by first loading 2 bytes into the AX register and then transferring them from AX to ES. The necessary instructions are

BB,00,00	(move to AX the values 00,00)
8E,C0	(move to ES from AX)

The 2-byte values 00 represent values that must be put into the program by the POKE command, prior to execution if the ES register address is required by the interrupt that calls the BIOS subroutine. The ES register is used only when defining a buffer address for a block of bytes to be either read in from or written out to a device such as a disk or a cassette.

The four accumulator registers, AX,

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BX, CX, and DX, can now be loaded with the following instructions, which are the same as those introduced in Part 1:

```
B8,00,00   (AX register)
BB,00,00   (BX register)
B9,00,00   (CX register)
BA,00,00   (DX register)
```

Now we can call the BIOS interrupt with the data statement

```
CD,00
```

Prior to executing the subroutine, we must replace the interrupt number, 00 here, with the interrupt number identifying the BIOS function we wish to perform, as identified in table 2 of Part 1 (November, pages 123-124).

After the subroutine is over, we want to examine the contents of some of the registers, which may contain either status information or data as described in table 2 of Part 1. The registers of possible interest are AX, BX, CX, and DX. To retain these values we use for each register a 3-byte instruction consisting of an operation code, a low-address byte, and a high-address byte.

The operation code identifies the register whose value is to be moved, and the two address bytes specify the offset address in memory where the register value is to be stored. To keep our program self-contained, we store these values in the bytes immediately following the end of the program. Normally, the instruction we use assumes that the segment address is contained in the DS register. However, to prevent complications we use the CS register, which already contains the segment address of the start of the program. This override of the segment address is accomplished by preceding each instruction with

```
2E (use CS register for the next
    instruction)
```

The required instructions are:

```
2E,89,06,30,00  (move AX to
                 memory offset
                 0030)
2E,89,1E,32,00  (move BX to
                 memory offset
                 0032)
2E,89,0E,34,00  (move CX to
                 memory offset
                 0034)
2E,89,16,36,00  (move DX to
                 memory offset
                 0036)
```

We determined these memory addresses by looking ahead to the end of the subroutine. The subroutine occupies offset positions decimal 0 to 47, so the register values can be stored starting at offset address decimal 48 or hexadecimal 30. Finally, we restore the register values from the stack with the instructions

```
07  (ES register value)
17  (SS register)
1F  (DS register)
5D  (BP register)
```

and issue the return statement to pass control back to the BASIC program, with the instruction

```
CB
```

The BASIC statements to load this subroutine into memory are provided in listing 1a. In listing 1b variables are assigned values equal to their offset positions in the program, thus providing self-documentation of the program and making it easier to use without having to recall any of the technical details. The PEEK and POKE statements that are implemented to retrieve or insert values can then use these variable names, as the following illustrates.

Disk Functions

To illustrate use of this subroutine, we will apply it to disk operations available in the BIOS. Typical actions we might want to perform include resetting the disk, reading the contents of one or more sectors of a track into memory at a specific buffer address, writing contents of a memory buffer onto one or more sectors of a track, and verifying data that has been written onto the disk.

Assuming that we will be using disk operations frequently in a program, we should now take the time

Text continued on page 422

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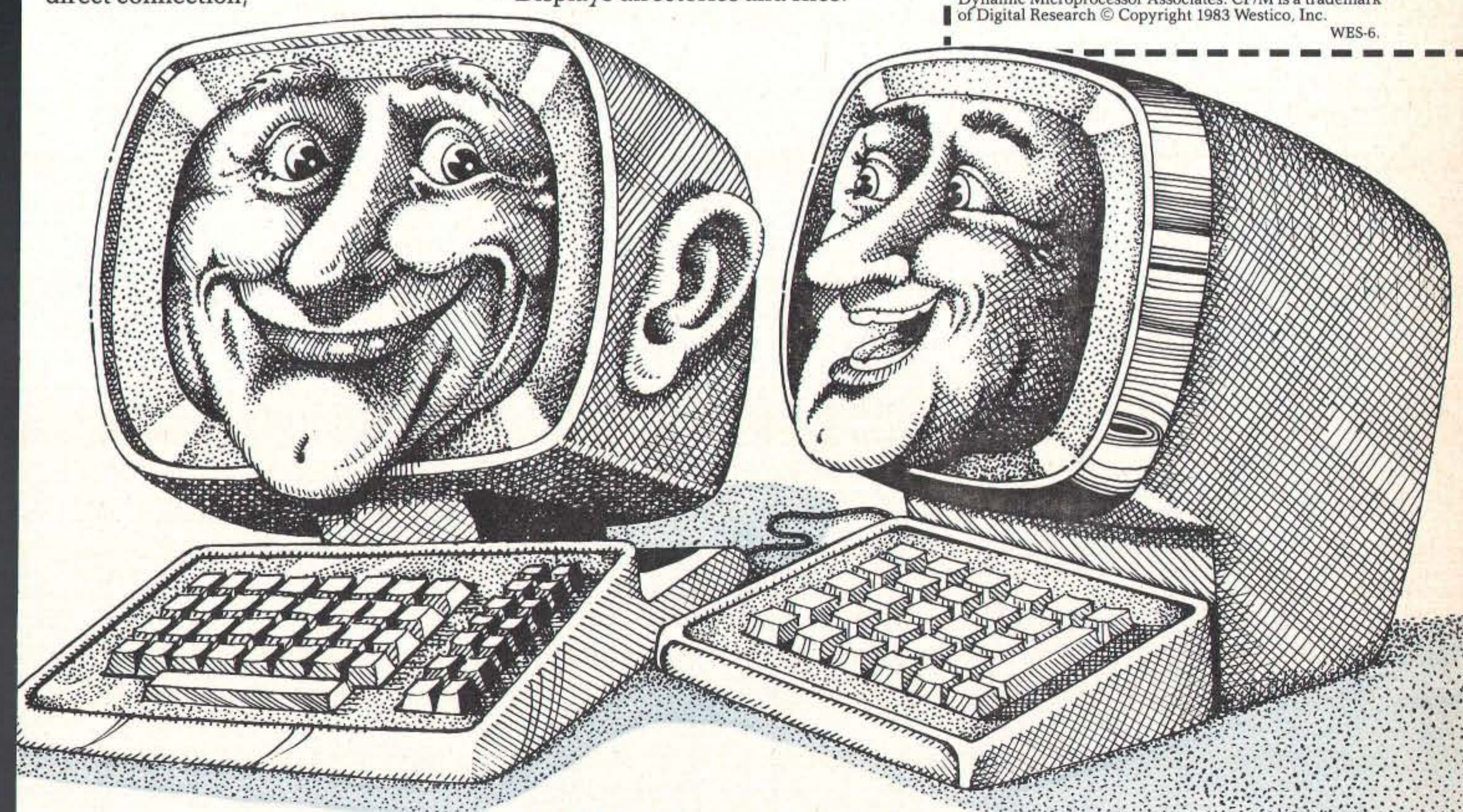

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Listing 1: *The BIOS interface subroutine (a) and its position constants (b).*

(1a)

```
10 '*************************************************************************
20 '
30 '
40 '                            demonstration program to create BIOS interface
50 '
60 '
70 '*************************************************************************
80 '
90 '
100 CLEAR , &H8000
110 DEFINT A-Z
120 SUBROUTINESEG=&HF00
130 GOSUB 1000
140 STOP
150 '
160 '
170 '***********************************************************************
180 '
190 '
1000 '                          initialize BIOS subroutine
1010 '
1020 '
1030 DEF SEG = SUBROUTINESEG
1040 FOR I=0 TO 47
1050    READ J
1060    POKE I,J
1070 NEXT I
1080 '                          push BP, DS, SS, ES onto stack
1090 DATA &h55,&h1e,&h16,&h06
1100 '                          move 00,00 to AX
1110 DATA &Hb8,&h00,&h00
1120 '                             and transfer to ES
1130 DATA &H8e,&hd8
1140 '                          move 00,00 to AX
1150 DATA &hb8,&h00,&h00
1160 '                                          BX
1170 DATA &hbb,&h00,&h00
1180 '                                          CX
1190 DATA &hb9,&h00,&h00
1200 '                                          DX
1210 DATA &hba,&H00,&H00
1220 '                          call interrupt 00
1230 DATA &Hcd,&H00
1240 '                          move AX to memory
1250 DATA &h2e,&h89,&h06,&h30,&h00
1260 '                                 BX
1270 DATA &h2e,&h89,&h1e,&h32,&h00
1280 '                                 CX
1290 DATA &H2e,&h89,&h0e,&h34,&h00
1300 '                                 DX
1310 DATA &h2e,&h89,&h16,&h36,&h00
1320 '                          restore ES, SS, DS, BP
1330 DATA &h07,&h17,&h1f,&h5d
1340 '                          return
```

Listing 1a continued on page 422

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Listing 1a continued:

```
1350 DATA &hcb
1360 '
1370 '
1380 '##########################################################################
```

(1b)

```
1390 '##########################################################################
1400 '
1410 '
1420 '                              define position constants
1430 '
1440 '
1450 BIOSSUB  = 0
1460 ESHI     = 6
1470 ESLO     = 5
1480 AXHI     =11
1490 AXLO     =10
1500 BXHI     =14
1510 BXLO     =13
1520 CXHI     =17
1530 CXLO     =16
1540 DXHI     =20
1550 DXLO     =19
1560 INTERRUPT=22
1570 RTNAXHI  =49
1580 RTNAXLO  =48
1590 RTNBXHI  =51
1600 RTNBXLO  =50
1610 RTNCXHI  =53
1620 RTNCXLO  =52
1630 RTNDXHI  =55
1640 RTNDXLO  =54
1650 '
1660 '
1670 RETURN
1680 '
1690 '
1700 '##########################################################################
```

Text continued from page 418:

to redefine the position variables in terms of the disk function, as follows:

ACTION = AXHI
DRIVE = DXLO
HEAD = DXHI
TRACK = CXHI
SECTOR = CXLO
NUMBEROFSECTORS = AXLO
BUFFERSEGMENTHI = ESHI
BUFFERSEGMENTLO = ESLO
BUFFEROFFSETHI = BXHI
BUFFEROFFSETLO = BXLO
STATUS = RTNAXHI
STATUSSECTORS = RTNAXLO

We can then define the action codes, using the values given in table 2 of Part 1 for the disk function as follows:

RESETDISK = 0
READDISK = 2
WRITEDISK = 3
VERIFYDISK = 4

With these preliminary definitions completed, we can use the subroutines at any point in our program by using POKE to input the appropriate values, calling the subroutine, and by using PEEK on the status bytes to determine the status of the operation.

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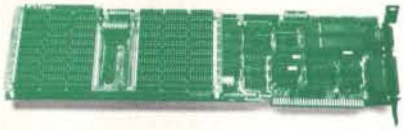

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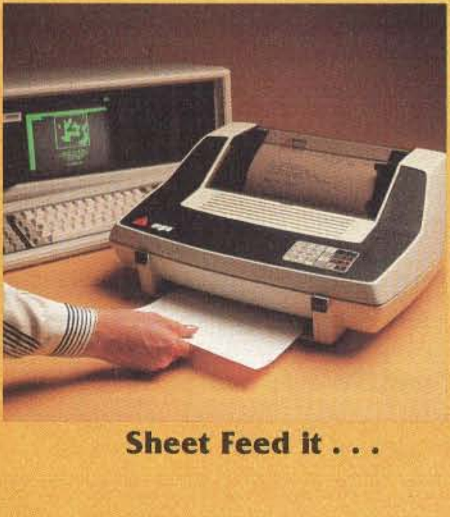

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Assume that we want to read data from a disk and store it in memory. First we must decide where in the memory space to place the data buffer. For a 128K-byte machine we might start the buffer at segment 1000, offset 0000. These values are entered into the subroutine with

```
DEF SEG = &H0F00
POKE BUFFERSEGMENTHI,
  &H1000
POKE BUFFERSEGMENTLO,
  &H0000
POKE BUFFEROFFSETHI,&H0000
POKE BUFFEROFFSETLO,&H0000
```

Let us say that the data is to be read from disk drive 0, head 0, track 38, starting at sector 1 and reading three contiguous sectors. This sequence is specified with

```
POKE ACTION,          READDISK
POKE DRIVE,                  0
POKE HEAD,                   0
POKE TRACK,                 38
                    (or &H26)
POKE SECTOR,                 1
POKE NUMBEROFSECTORS,        3
```

Finally, we need to specify the interrupt number, 13, for the disk function, call the subroutine, and retrieve the status results with

```
POKE INTERRUPT, &H13
CALL BIOSSUB
DISKSTATUS = PEEK(STATUS)
SECTORSTATUS = PEEK(STATUS
                   SECTORS)
```

These statements will initiate the reading of the disk, and the contents will be transferred to memory.

The BASIC program should first check that the disk status is zero, indicating a successful operation. If unsuccessful, the standard procedure is to reset the disk and reread, repeating this attempt up to three times. Once the data is in memory, it can be manipulated by the program using standard BASIC statements, starting with PEEK and POKE statements to examine individual bytes.

There are two limitations to note in the above procedure. First, it is not possible to read or write to a disk directly from a buffer defined in the screen-memory space. The screen-memory buffer-access timing is coordinated with the screen character-generator, which inhibits its use directly as a buffer for disk I/O (input/output). This limitation can be overcome easily by moving data between screen memory and regular memory, as we will illustrate later. Also, in the BIOS I use, the status report of the number of sectors actually written or read, which should be returned in the AL register, does not function, and the register has the value of zero whether or not the action was successful. This condition should not be a serious problem for most operations.

This subroutine can be used, unchanged, for any of the BIOS functions. Only use of the POKE statement to input the necessary parameter values to define the action desired is necessary. This subroutine is an efficient way to control the I/O devices from a BASIC program, and it may be a useful way for you to explore the BIOS routines yourself.

I originally developed this subroutine for a disk-utility program that can list the directory and the file-allocation table and examine or change any sector of a disk without being constrained by using DOS. This program was not difficult to develop, as it was possible to work entirely in BASIC once the preceding subroutine was developed.

In the previous subroutines we have used POKE to enter parameter values into the machine-language subroutine. It is also possible to pass values between the BASIC program and the subroutine as arguments of the CALL statement. This procedure makes the machine-language program slightly more complicated to develop but provides a more flexible interface between the main program and the subroutine. The use of arguments will be illustrated in the final program.

Moving Data within Memory

One use of a program to move data within memory is in screen applications. For example, for text or graphics applications you may wish to create a working memory area that is larger than the screen memory. The screen then becomes a window that can be moved around to examine the various portions of the larger representation stored in memory. While this can be done within BASIC, using PEEK and POKE commands, the speed of the resulting program is too slow for most practical applications.

There is a machine-language instruction that directs the central processing unit to move data from a source address in memory to a destination address. The operation code is A4 if 1 byte is to be moved and A5 if a 2-byte word is to be moved. The source-offset address is specified by the contents of the source-index (SI) register in conjunction with the segment address contained in the data-segment (DS) register. The destination-offset address is taken from the destination-index (DI) register together with the segment address contained in the extra-segment (ES) register. As part of the MOV instruction, SI and DI are automatically incremented or decremented to point to the next memory locations. The direction of these automatic address changes is controlled by one of the status-register flags, appropriately named the direction flag. If this flag is set to the value 0, SI and DI will be incremented; if set to the value 1, those registers will be decremented.

This MOV instruction is particularly attractive because it may be preceded by a single-byte prefix that specifies that the MOV instruction is to be repeated continuously until the CX register has the value zero. This is referred to as the REP prefix, machine code F3. The REP instruction logic automatically decrements the CX register with each MOV instruction. Therefore, it provides a complete looping facility, and we need only load the number of bytes or words to be moved into the CX register, prior to the command, and the move will continue automatically until the specified amount of data is moved. We can now proceed to develop the subroutine.

The first step of our subroutine will be to store the current segment reg-

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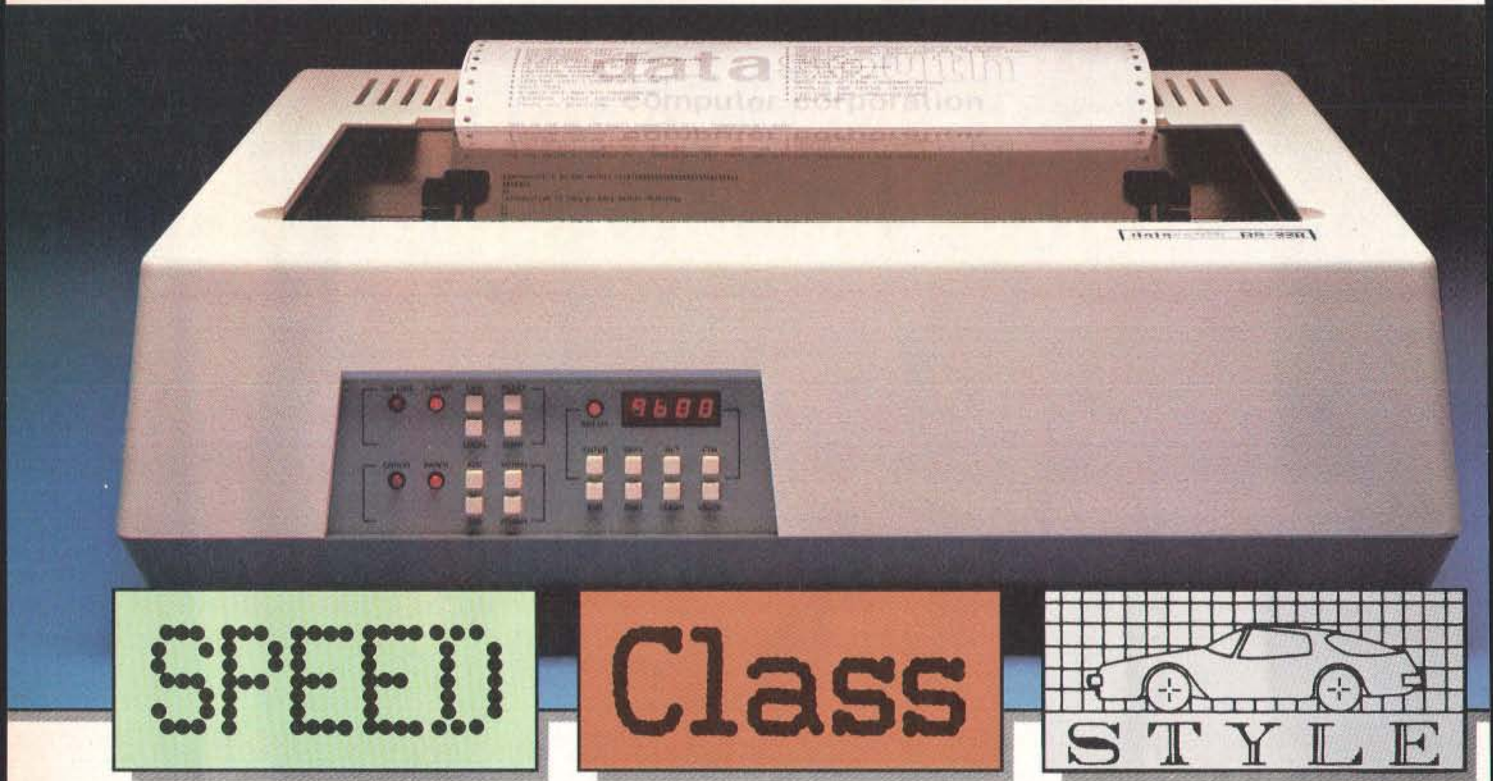

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ister values on the stack so that they may be restored prior to returning to the calling program. Because we will use only the DS and ES segment registers, we need to save only these. This is done with the following two instructions:

1E for the DS register
06 for the ES register

Let's assume we want to store the current contents of the screen, which begins at the source address B000:0000. The destination address of where we want to store the contents will be 1000:0000. The full screen contains 1920 words (24 rows by 80 columns, with 2 bytes for each character), or 780 words in hexadecimal. The addresses should be incremented because we will be storing the screen characters from top to bottom.

First we will move the addresses into the appropriate registers. Recall that it is necessary, when loading data into the segment registers, to load the value first into the AX register and then transfer it from the AX register to the desired segment register.

Therefore, the required instructions are as follows:

B8,00,B0 (load the source segment into AX)
8E,8D (transfer AX to DS)
BE,00,00 (load the source offset into SI)
B8,00,10 (load the destination segment into AX)
8E,C0 (transfer AX to ES)
BF,00,00 (load the destination offset into DI)
B9,80,07 (load CX with the word count)
FD (clear the direction flag)

We are now ready to issue the move instruction

F3,A5

Then we restore the registers and return to the calling program with

07,17,CB

The actual BASIC statements are il-

Listing 2: *A subroutine that moves data within memory (a) and its position constants (b).*

(2a)

```
680 '################################################################################
690 '
700 '
710 '                         "movesub" - machine language subroutine
720 '
730 '
740 DEF SEG=SUBROUTINESEG
750 FOR I=0 TO 26
760    READ J
770    POKE I,J
780 NEXT I
790 '                         push DS, ES onto stack
800 DATA &h1e,&h06
810 '                         load source seg address into AX
820 DATA &hb8,&h00,&hb0
830 '                         and transfer to ES
840 DATA &h8e,&hd8
850 '                         load source offset into SI
860 DATA &hbe,&h00,&h00
870 '                         load destination seg address into AX
880 DATA &hB8,&h00,&h10
890 '                         and transfer to DS
900 DATA &h8e,&hc0
910 '                         load destination offset into DI
920 DATA &hbf,&h00,&h00
930 '                         load word count into CX
940 DATA &hb9,&h80,&h07
950 '                         set direction flag
960 DATA &hfc
970 '                         move instruction
980 DATA &hf3,&ha5
990 '                         "pop" (recover) register values from stack
1000 DATA &h07,&h1f
1010 '                         return to calling program
1020 DATA &hcb
1030 '
1040 '
1050 '################################################################################
```

(2b)

```
1050 '################################################################################
1060 '
1070 '
1080 '                         define position values for subroutine
1090 '
1100 '
1110 MOVESUB            = 0
1120 SOURCESEGHI        = 4
1130 SOURCESEGLO        = 3
1140 SOURCEOFFSETHI     = 9
1150 SOURCEOFFSETLO     = 8
1160 DESTINATIONSEGHI   =12
1170 DESTINATIONSEGLO   =11
1180 DESTINATIONOFFSETHI=17
```

Listing 2b continued on page 428

Listing 2b continued:

```
1190 DESTINATIONOFFSETLO=16
1200 WORDCOUNTHI        =20
1210 WORDCOUNTLO        =19
1220 RETURN
1230 '
1240 '
1250 '*************************************************************************
```

lustrated in listing 2a. If we give the subroutine the name Movesub, then it can be executed at any time from the BASIC program with the statement

CALL MOVESUB

For ease of use, we have defined the position values as illustrated in listing 2b. Now if we want to change the parameters so that a second call to the subroutine will store new screen data in memory, adjacent to the first block of data, that is, starting at offset address 780, we would require the following BASIC statements:

```
DEF SEG=SUBROUTINESEG
POKE DESTINATIONOFFSET-
  HI,07
POKE DESTINATIONOFFSET-
  LO,80
POKE WORDCOUNTHI,07
POKE WORDCOUNTLO,80
CALL MOVESUB
```

and the move will be executed very quickly.

Interfacing with DOS

Earlier, we discussed the use of the BIOS disk functions to read or write data records directly onto disks. This approach can be useful for some applications, but it leaves the user with considerable responsibility for keeping track of what information is located where on the disk, checking that data is read and written correctly, taking corrective action if there are faulty sectors on the disk, and so on. These support facilities are all provided by DOS, so the final subroutine will demonstrate how to interface with DOS. This program is not new but rather is an application of the Move subroutine developed earlier. One instance in which this program might be used is when we want to store the contents of the current screen display on a disk, or, conversely, retrieve a particular screen display that is stored on a disk.

To develop this application program, it is necessary to review the structure and role of the file-control block (FCB) used by a BASIC program to communicate with DOS. For each file that is opened in a BASIC program, an FCB is created in the main memory space to serve as the interface between the BASIC program and the DOS. The layout of this FCB is described in the IBM *BASIC* manual, chapter 4, as part of the discussion of the VARPTR (variable pointer) command. The BASIC statement

y = VARPTR(#file number)

assigns to the variable *y* the offset address of the first byte of the FCB for a file opened as the specified file number. This offset address can be used in conjunction with the segment address of the BASIC program to establish the absolute memory address of the start of the FCB.

It is not necessary to examine the detailed layout of the FCB as it is clearly described in the *BASIC* manual. The section that is of interest for our purpose is the data-buffer portion of the block. This buffer begins at byte-offset position 188. The length of this buffer's data field is defined when you first initiate the BASIC program with the /S:(buffer size) command. (The proper form of this command for the programs presented here is /S:512, yielding a decimal 512-byte data-buffer size.) In normal BASIC operations on random files, the FIELD statement is used to point to this data buffer. Our objective in this subroutine is to bypass the FIELD statement, which can be too restrictive when we want to move relatively large amounts of data into and out of the buffer and across segment boundaries.

Given the accessibility of the FCB's data buffer, we can move data between the screen and the disk by using the Move subroutine developed above and assigning to it the address of the data buffer as either the source or destination address, depending on the direction in which we want to move data. The GET or PUT statements can be used to initiate the transfer of data between the buffer and the disk.

The VARPTR statement returns the address of the start of the FCB, and an increment of 188 gives the offset address of the first byte of the data buffer. However, we also require the segment address of the start of the BASIC workspace. This address is stored in reserved-memory locations 510-511 (*Technical Reference* manual, pages 3-22). Therefore, it will be necessary to extract this segment address using two PEEK statements.

This completes the technical information necessary for the DOS interface. The application will be illustrated in the last program.

Arguments of CALL

It will often be more practical to pass values to the machine-language subroutine as arguments of the CALL statement than to use POKE to input such values to the program as we have done in previous examples. To illustrate how this can be done we'll develop a program that transfers data between the screen and disk through DOS.

This complete program enables you to create an image on the screen and then save it on a disk or to have an image previously stored on a disk transferred to the screen. Function keys are used to control the actions of the program, which include clearing the screen, getting a screen image from a disk, transferring a screen

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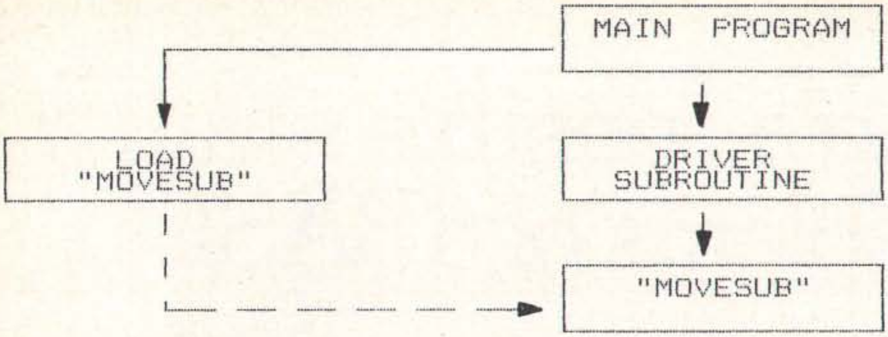

Figure 1: *The structure of a program that moves data between a disk and the screen.*

(1a)

	1st argument	SOURCE SEGMENT
	2nd argument	SOURCE OFFSET
	3rd argument	DESTINATION SEGMENT
	4th argument	DESTINATION OFFSET
	5th argument	WORDCOUNT
	CS register	RETURN
SP→	PC register	ADDRESS

(1b)

	1st argument
	2nd argument
	3rd argument
	4th argument
	5th argument
	CS register
	PC register
	DS register
	ES register
SP→	BP register

Table 1: *The stack at the time of a subroutine call (a) and an illustration of the effect of pushing register contents onto the stack (b).*

image to a disk, and stopping the program. The structure of the complete program is illustrated in figure 1.

The program starts by calling a subroutine to load the machine-language subroutine, a revised version of Movesub, into memory. The main program then executes the actions you have chosen. Whenever you wish to transfer data between a disk and the screen, the main program calls a driver subroutine to effect the transfer. The driver subroutine will use the Movesub routine as required. A listing of the main program is illustrated in listing 3a, and two of the supporting subroutines are illustrated in listing 3b.

The drive subroutines (listing 4) are responsible for transferring one complete screen image to, or from, the disk. As noted previously, the screen contains a total of 1920 words, or 3840 bytes. Because a sector of disk can store only 512 bytes of data, eight sectors will be required for each screen image. The driver subroutines are responsible for controlling this data

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flow and allocation of disk space. Note that the calls to Movesub have five arguments that represent source segment, source offset, destination segment, destination offset, and number of words to move.

The machine-language subroutine closely follows the method described in Appendix C of the IBM *BASIC* manual. When control is transferred to the machine-language program by the CALL statement, the memory addresses of the argument values are available in the stack pointed at by the SP. The stack also contains the code-segment address and program-counter address at the time of the call, to be used when control is returned to the calling program. The structure of the stack at this point is illustrated in table 1a.

The subroutine begins by storing register values DS, ES, and BP onto the stack with the resulting changes as illustrated in table 1b. The SP is copied into the base pointer (BP). We can then use the machine instruction

```
36,8B,5E,xx
```

which will copy into BX the 2 bytes stored at the memory location pointed at by BP plus the offset xx contained in the last byte of the instruction. By assigning the appropriate value to this offset, we can select whichever argument address we want from the stack, as illustrated by the repetitive use of this instruction in listing 5. Once the address of the argument is loaded into BX, the actual value can be transferred directly into the desired register as illustrated in the program.

The balance of the program is a repetition of the previous subroutine with the exception of the final statement, the return to the calling program. When arguments have been passed by the CALL statement, it is necessary to adjust the SP to bypass these arguments, effectively removing them from the stack. The adjustment to the pointer is two times the number of arguments, in this case 2 times 5 (or 10). This adjustment is made by using a different version of the return instruction, CA, followed by the adjustment, resulting in the

Text continued on page 438

Listing 3: *The main program that transfers data between disk and screen (a) and its supporting subroutines (b).*

(3a)

```
10 '***************************************************************************
20 '
30 '                              program to move data between screen & diskette
40 '                              -illustration of call statement with arguments
60 '                                 call movesub (source segment, source offset,
70 '                                    dest. segment, dest. offset, wordcount)
80 '
90 '***************************************************************************
100 '
110 '
120 DEFINT A-Z
130 CLEAR ,&HB000
140 SUBROUTINESEG%=&HF00
150 OPEN "B:SCREEN" AS #1 LEN=512
160 GOSUB 720                 'initialize "movesub"
170 '
180 '
190 '                             main program
200 '
210 '
220 CLS                          'clear screen and initialize function keys
230 KEY OFF
240 KEY (1) ON
250 KEY (2) ON
260 KEY (9) ON
270 KEY (10) ON
280 ON KEY (1) GOSUB 490         'stop
290 ON KEY (2) GOSUB 620         'clear screen
300 ON KEY (9) GOSUB 1500        'disk to screen
310 ON KEY(10) GOSUB 1250        'screen to disk
320 '
330 '
340 LOCATE 25,1                  'action control loop
350 BEEP
360 PRINT "Write on screen, or ENTER for next action                   ";
370 INPUT; "", ZZZ$
380 LOCATE 25,1
390 BEEP
400 PRINT "F1-stop  F2-clear screen  F9-disk to screen  F10-screen to disk";
             SPACE$(15);
410 GOTO 410                     'wait for function key
420 STOP
430 '
440 '
450 '***************************************************************************
```

(3b)

```
460 '***************************************************************************
470 '
480 '                             "stop" subroutine
490 CLOSE #1
500 KEY (1) OFF
510 KEY (2) OFF
520 KEY (9) OFF
530 KEY (10) OFF
```

Listing 3b continued on page 434

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Listing 3b continued:

```
540 KEY ON
550 RETURN 420
560 '
570 '
580 '**************************************************************************
590 '
600 '                              clear screen subroutine
610 '
620 '
630 CLS
640 RETURN 340
650 '
660 '
670 '***********************************************************************
```

Listing 4: *Driver subroutines for disk-screen data transfers.*

```
1220 '**************************************************************************
1230 '
1240 '
1250 '                         "move screen to disk" - driver subroutine
1260 '
1270 '
1280 LOCATE 25,1:PRINT SPACE$(79);
1290 LOCATE 25,1
1300 BEEP
1310 DEF SEG:POKE 106,0
1320 INPUT; "F-10  screen to disk; enter screen image #:",SCREENIMAGE%
1330 SCREENOFFSET%=0
1340 WORDCOUNT%=256
1350 DEF SEG=SUBROUTINESEG%
1360 FOR RECORDNO%=SCREENIMAGE%*8 TO SCREENIMAGE%*8+6
1370    CALL MOVESUB%(SCREENSEG%,SCREENOFFSET%,FCBSEG%,FCB1DATAOFFSET%,
          WORDCOUNT%)
1380    PUT #1,RECORDNO%
1390    SCREENOFFSET%=SCREENOFFSET%+512
1400 NEXT RECORDNO%
1410 WORDCOUNT%=(24*80-7*256)
1420    CALL MOVESUB%(SCREENSEG%,SCREENOFFSET%,FCBSEG%,FCB1DATAOFFSET%,
          WORDCOUNT%)
1430 PUT #1, SCREENIMAGE%*8+7
1440 RETURN 340
1450 '
1460 '
1470 '**************************************************************************
1480 '
1490 '
1500 '                         "move disk to screen" - driver subroutine
1510 '
1520 '
1530 LOCATE 25,1:PRINT SPACE$(79);
1540 LOCATE 25,1
1550 BEEP
1560 DEF SEG:POKE 106,0
1570 INPUT: "F-9  disk to screen: enter screen image #:",SCREENIMAGE%
```

Listing 4 continued on page 436

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Listing 4 continued:

```
1580 SCREENOFFSET%=0
1590 WORDCOUNT%=256
1600 DEF SEG=SUBROUTINESEG%
1610 FOR RECORDNO=SCREENIMAGE%*8 TO SCREENIMAGE%*8+6
1620     GET #1,RECORDNO
1630     CALL MOVESUB%(FCBSEG%,FCB1DATAOFFSET%,SCREENSEG%,SCREENOFFSET%,
            WORDCOUNT%)
1640     SCREENOFFSET%=SCREENOFFSET%+512
1650 NEXT RECORDNO
1660 WORDCOUNT%=(24*80-7*256)
1670 GET #1, SCREENIMAGE%*8+7
1680 CALL MOVESUB%(FCBSEG%,FCB1DATAOFFSET%,SCREENSEG%,SCREENOFFSET%,WORDCOUNT%)
1690 RETURN 340
1700 '
1710 '
1720 '************************************************************************
```

Listing 5: *A subroutine with CALL arguments.*

```
680 '*************************************************************************
690 '
700 '
710 '                          "movesub" - machine language subroutine
720 '                                    - call statement with arguments
730 '
740 DEF SEG=SUBROUTINESEG%
750 RESTORE 810
760 FOR I=0 TO 48
770     READ J
780     POKE I,J
790 NEXT I
800 '                          push DS, ES, BP onto stack; move SP to BP
810 DATA &h1e,&h06,&h55,&h8b,&hec
820 '                          load 1st argument address into BX
830 DATA &h36,&h8b,&h5e,&h12
840 '                            and get value into DS
850 DATA &h36,&h8e,&h1f
860 '                          load 2nd argument address into BX
870 DATA &h36,&h8b,&h5e,&H10
880 '                            and get value into SI
890 DATA &h36,&h8b,&h37
900 '                           load 3rd argument address into BX
910 DATA &h36,&h8b,&h5e,&h0e
920 '                             and get value into ES
930 DATA &h36,&h8e,&h07
940 '                           load 4th argument address into BX
950 DATA &h36,&h8b,&h5e,&h0c
960 '                             and get value into DI
970 DATA &h36,&h8b,&h3f
980 '                           load 5th argument address into BX
990 DATA &h36,&h8b,&h5e,&h0a
1000 '                             and get value into CX
1010 DATA &h36,&h8b,&h0f
1020 '                          set direction flag
1030 DATA &hfc
1040 '                          move instruction
```

Listing 5 continued on page 438

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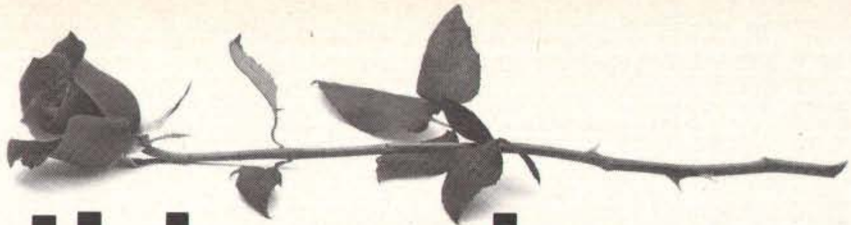

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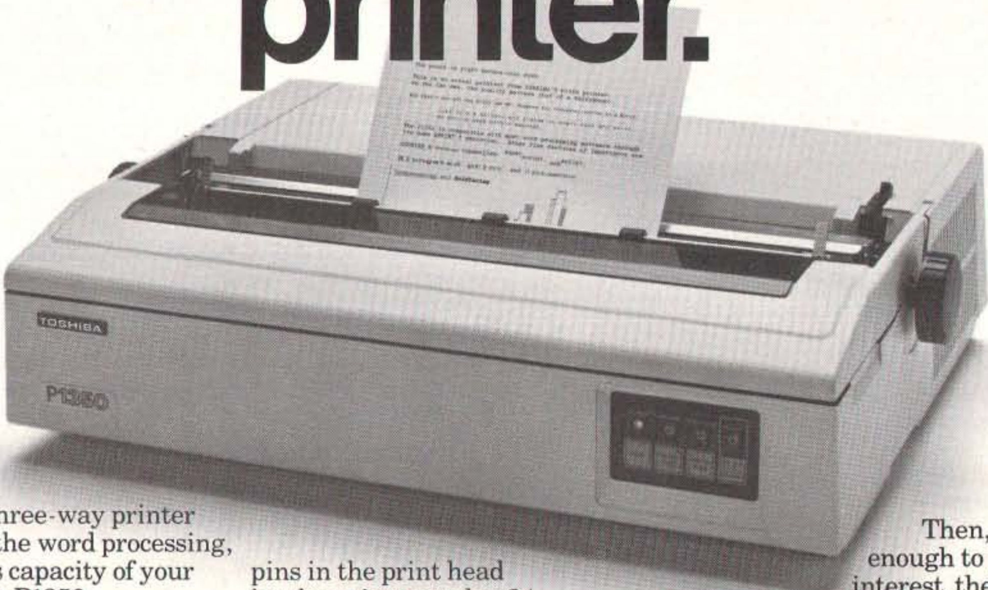

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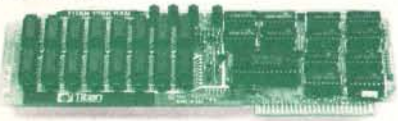

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Listing 5 continued:

```
1050 DATA &hf3,&ha5
1060 '                         "pop" (recover) register values from stack
1070 DATA &h5d,&h07,&h1f
1080 '                         return with displacement value A(=2*5 arguments)
1090 DATA &hca,&h0a,&h00
1100 '
1110 '                         define constants
1120 '
1130 MOVESUB%=0
1140 SCREENSEG%=&HB000
1150 SCREENOFFSET%=&H0
1160 DEF SEG=&H0
1170 FCBSEG%=PEEK(&H511)*256+PEEK(&H510)  'BASIC segment address
1180 FCB1DATAOFFSET%=(VARPTR(#1)+188)
1190 RETURN
1200 '
1210 '
1220 '*************************************************************************
```

Text continued from page 432:

complete instruction

CA,0A,00

There is one important cautionary comment to note in transferring memory addresses as arguments of a CALL statement, as we have done in this case. Here we wanted to transfer addresses for the source, destination, and word counts, as values for this subroutine. These addresses must be transferred as 2-byte integer representations. IBM BASIC has a peculiarity concerning the representation of integers. When integer variables are declared using the DEFINT statement at the start of a program, the variables represent integer values externally but, in fact, are stored in memory in 4, rather than 2, bytes. This representation cannot be used for these machine programs. Only when each integer variable is declared to be an integer by having the suffix "%" added will the representation in memory be in true 2-byte integer form. For this reason all of the variables, such as Sourceseg%, include the necessary suffix.

Conclusion

The objective of this discussion of the use of POKEing in the IBM PC has been to illustrate several short, powerful machine-language subroutines that can be incorporated into a BASIC program. These subroutines provided access to the facilities of the BIOS for peripheral device control and methods for moving data from one location to another in memory, particularly interfacing with DOS and disk storage. The advantages of this approach are to combine the speed and efficiency of machine-level subroutines for performing routine and high-volume operations with the simplicity of using BASIC for developing the logic for a specific application.

For those readers who have not had extensive contact with machine-language programs, I hope that these examples enable you to investigate the PC and its inner workings and provide a useful tool for the development of your own applications.■

For Futher Information

For further information on the machine and assembly language of the 8086 of the IBM PC, refer to *The 8086 Book* by Russell Rector and George Alexy (Berkeley, CA: Osborne/McGraw-Hill, 1980).

Hugh R. Howson, Ph.D., C.A., is on the faculty of Management at McGill University (1001 Sherbrooke St. W, Montreal, PQ, Canada H3A 1G5).

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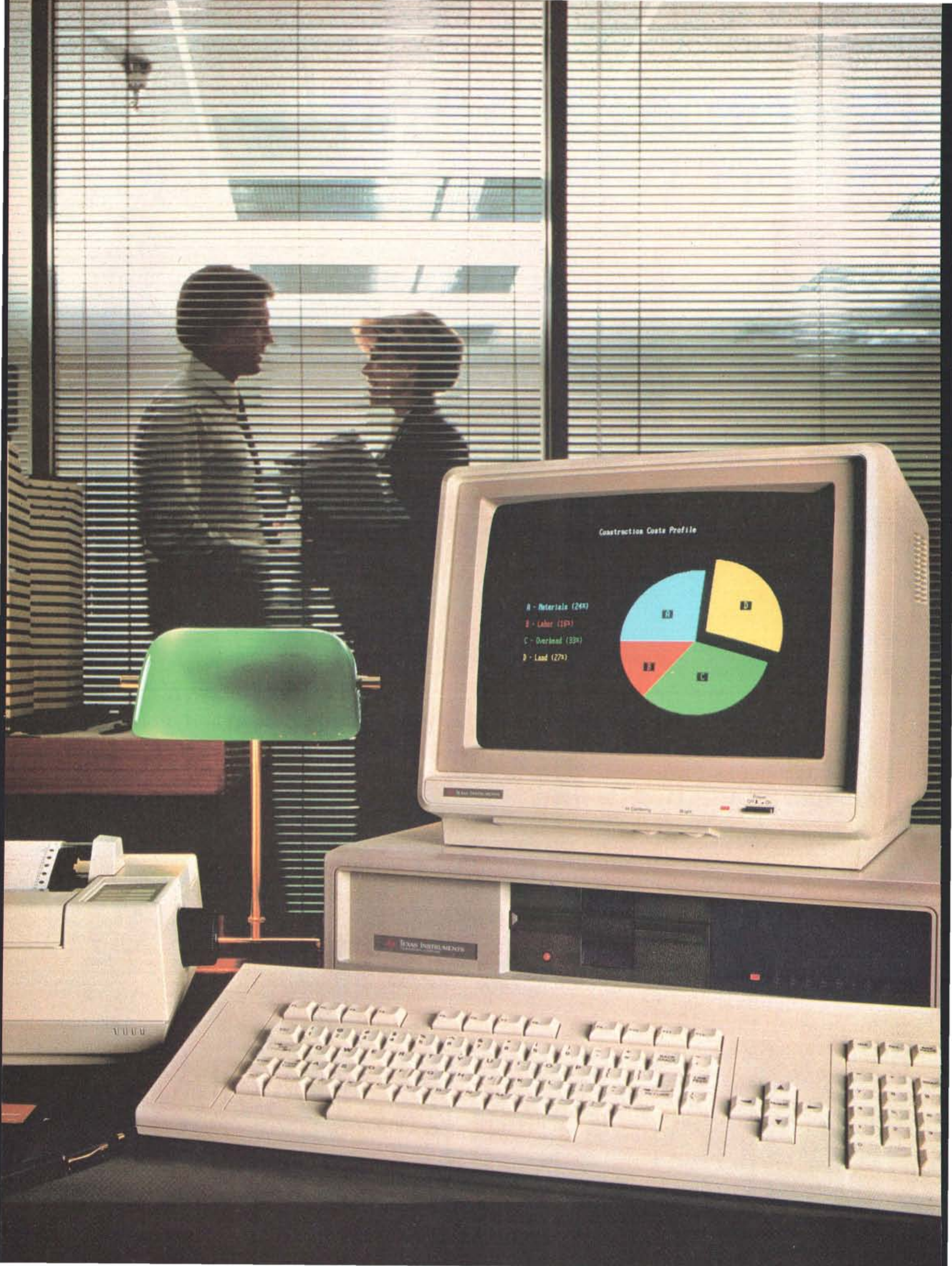
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The CMOS 6502

A new version of the 6502 microprocessor does more than save power—it includes powerful new instructions

by Steven Hendrix

Rockwell has introduced a CMOS (complementary metal-oxide semiconductor) version of the 6502 microprocessor that fills a number of gaps in the standard 6502's instruction set while offering the low power-consumption advantages of CMOS technology. Pin and software compatible with the standard 6502 chip, the CMOS version (designated the R65C02) promises to extend the range of applications that 6502-based packages can serve.

A mainstay of the personal-computer industry since the first Apple computer was produced, the standard 6502 microprocessor has a simple, straightforward instruction set and simple interfacing requirements. The instruction set at first appears to be restricted in comparison to other 8-bit processors such as the Z80, but, in practice, the simplicity of the instruction set often yields a shorter, faster program for common microprocessor applications. The instruction set does have restrictions on the use of certain addressing modes with some instructions and has several minor anomalies that are poorly documented.

In this article I will discuss some of the 6502's lesser-known deficiencies and the changes in the CMOS version that correct some of these problems. I will also review the CMOS version's instructions and added addressing modes, and finally I will describe some hardware interfacing considerations.

Several 6502 instructions don't behave as you might expect them to.

Quirks of the 6502

Several instructions on the 6502 do not behave as the documentation would have you believe. These irregularities rarely affect programs, which makes them more difficult to debug when they do enter into a program. The quirks discussed here pertain to the return-from-interrupt instruction, the branch-instruction timing, the absolute indirect-addressing mode, and bus cycles on certain index-addressing modes. The CMOS version's design has not altered the return-from-interrupt and branch-instruction timing; therefore, the information presented on these topics pertains to both the standard and CMOS versions of the 6502. The CMOS version's design, however, has corrected the absolute indirect-addressing mode and bus-cycle anomalies.

RTI versus RTS

The RTI (return-from-interrupt) instruction appears functionally equivalent to the sequence PLP (pull status register from stack), RTS (return from subroutine). An interrupt is acknowledged at the end of an instruction, at which time the processor pushes the contents of the program counter on the stack, high byte followed by low byte, and then pushes the processor-status byte on the stack before jumping through the interrupt vector to the interrupt-handling routine.

The difference between the RTI instruction and the PLP, RTS sequence lies in the sequence in which the program counter is incremented. During a JSR (jump to subroutine), the value pushed on the stack is the address of the third byte of the JSR instruction. Thus, the program counter is reloaded during an RTS instruction and then incremented before the attempt to fetch the next instruction. An interrupt pushes the address of the first byte of the next instruction to be executed, so the RTI instruction reloads the program counter and fetches the next instruction without first incrementing the program counter. This difference becomes especially important in writing software for tracing or single-stepping functions.

Branch-Instruction Timing

The branch-instruction timing problem lies not with the 6502, but rather with its documentation. The original data sheets specify the timing correctly, but several independent tutorials have incorrectly stated how long a branch instruction takes.

Unlike most other 6502 instructions, a branch instruction requires a variable number of clock cycles—from two to four, depending on the circumstances surrounding the branch.

During the first clock cycle (bus cycle), the processor fetches the branch op code. The second cycle fetches the second byte of the instruction, which is the offset to be used if the branch is taken.

Several independent tutorials have confused 6502 branch-instruction timing considerations.

If the branch condition (flag set or cleared) is not met, the fetch for the next instruction occurs during the next clock cycle. If the branch is taken, the next cycle is used to add the offset to the low-order byte of the program counter. If there is a carry or borrow from this operation (considering the offset to be a signed value), a fourth clock cycle is used to update the high-order byte of the program counter.

The net result is that a branch that is not taken requires two clock cycles. A branch to a location within the same page requires three clock cycles, and only in the case of a branch that crosses a page boundary does the instruction require the full four cycles. Typical timing loops, especially for intervals under a millisecond or so, require close attention to these details of the branch-instruction timing.

Absolute Indirect Mode Wraparound

The absolute indirect-addressing mode works only with the JMP (jump) instruction. In normal use, it is a 3-byte instruction: the first byte contains the op code (6C)(all instructions and addresses are specified in hexadecimal); the second byte contains the low-order part of a memory address; and the third byte contains the high-order part of that address. The processor loads the byte at the referenced address into the low half of the program counter, and it loads the byte in the next higher memory location into the high half of the program counter. Thus, the instruction's effect is to jump to the location specified by the two bytes stored at the address given in the instruction.

A problem arises, however, when the jump destination is stored with the two bytes split between two memory pages (that is, if the second byte of the instruction is FF). The processor loads the referenced byte into the low half of the program counter and attempts to increment the address given in the instruction to load the high byte. However, it disregards the carry from the increment operation on the low byte of the address, with the result that the high byte of the program counter is loaded from the memory location 255 bytes prior to the referenced location.

In table 1 the JMP instructions illustrate this problem. The left-hand-column code operates correctly, loading the value A345 into the program counter. The right-hand-column code, however, does not correctly load the value A345 into the program. It does load the value 45, stored at location 02FF, into the program counter's low-order byte, but

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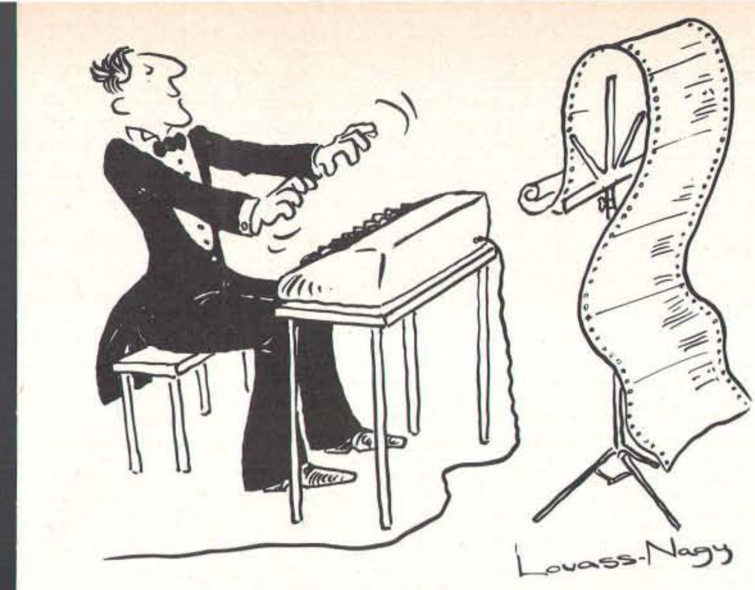

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```
A345 JMP (0200)        A345 JMP (02FF)
0200 45                0200 59
0201 A3                02FF 45
                       0300 A3
Result: A345 → PC      Result: 5945 → PC
```

Table 1: *Two sets of memory contents illustrating operation of the 6502 JMP instruction. The left-hand column of code operates as expected, but due to an instruction-set anomaly, the right-hand column's code yields an unexpected result because the program counter's desired high-order byte resides in a different page of memory than does the low-order byte.*

rather than transferring to the next page of memory to obtain the high-order program-counter byte from location 0300, it incorrectly loads the value stored at location 0200 (59 in this case) into the program counter's high-order byte.

This anomaly can cause major problems when you attempt to develop general-purpose table-driven software. If the application program does not contain special code to insure that an indirect jump never references an address at the end of a page, unpredictable behavior that is difficult to trace can result. The R65C02 reportedly handles the absolute indirect-addressing mode correctly for all cases.

Spurious Bus-Read Cycles

A rare problem with I/O (input/output) devices can occur because of the nature of the 6502 bus. Two specific factors combine to cause this problem: all I/O is memory-mapped, and there is no such thing as an inactive bus cycle. In some cases, indexed instructions can lead to inadvertent accesses to I/O devices because of these two facts.

The 6502 treats memory and I/O ports alike, viewing both as memory. As a result, a system's decoding hardware causes I/O ports to appear at specific locations that look like part of the memory-address space to the 6502. A "read" bus cycle addressing a port acts as an "input" operation, and a "write" cycle acts as an "output" operation.

The 6502 does not have separate pins for a "read" and a "write" signal, as do other processors such as the 8080 or the Z80. Instead, the R/W (read/write) signal is used to designate a "read" cycle if it is in a high state or a "write" cycle if it is in a low state. Timing is coordinated by the Phase 2 clock. If the read/write line is high when the Phase 2 clock is high, the device whose address appears on the address bus places data on the data bus. If the read/write line is low while the Phase 2 clock is high, the addressed device accepts data from the bus.

To show how indexed instructions can interfere with I/O devices, let's examine the bus cycles carried out to load the accumulator from an absolute address indexed by the X register. In standard 6502 mnemonics, this load instruction is LDA ADDR,X. This instruction takes four cycles unless the indexing crosses page boundaries, in which case it takes five. The latter is the troublemaker.

During the first cycle, the 6502 fetches the op code. The second and third cycles are used to fetch the low and high bytes of ADDR, respectively. If the indexing operation does not cross a page boundary, the sum of ADDR and X is placed on the address bus during the next cycle, and the A register is loaded from the data bus, finishing the instruction. If a page boundary is crossed, however, a partially formed address is placed on the bus during cycle four and the actual load happens in a fifth cycle. For normal memory access, the fifth cycle does no harm because it is a read cycle, resulting in memory placing data on the bus but no registers or memory being changed by it. (Even if the instruction is a store instruction, the cycle involving this partially formed address is a read cycle.)

Certain I/O devices, however, are affected by read operations. For instance, a spurious read from a 6850 ACIA (Asychronous Communications Interface Adapter) could reset the "receive data register full" flag, so that a later operation would find that data was not available. Various other I/O devices such as parallel ports and

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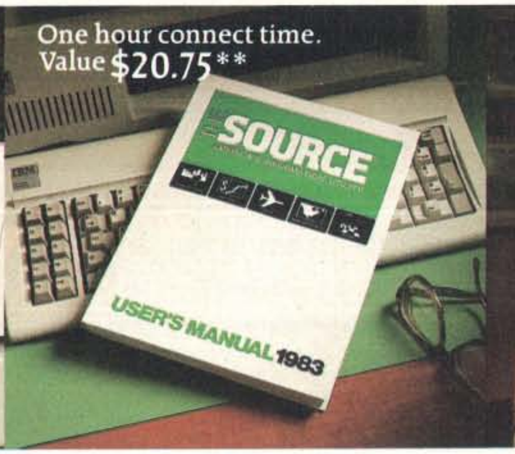

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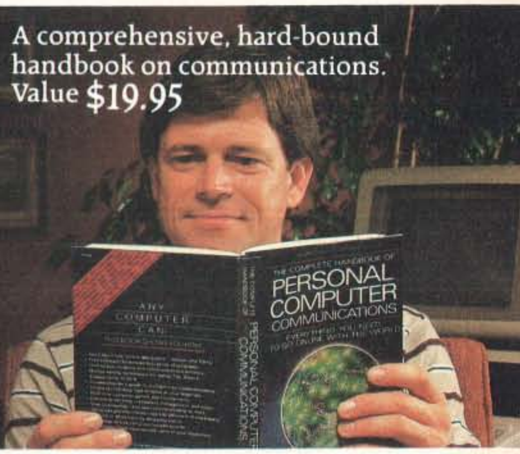

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counter/timers can also be affected by spurious reads. If the indexed address crosses a page boundary from the page in which the I/O device resides, the partially formed address placed on the bus during the fourth bus cycle can trip the I/O device. The R65C02 reportedly corrects this problem.

New Instructions

The R65C02 includes a number of new instructions, making it more powerful than the 6502. (The text box "An Assembler for the R65C02" on page 452 describes an assembler that supports the R65C02's extended instruction set.) Conditional branching based on the state of any bit in page 0, an unconditional short relative branch, stack operations for the X and Y registers, the ability to set or clear any individual bit in page 0, zeroing any byte in memory, and a "test and reset" or "test and set" memory bit instruction have been added.

The BBRx (branch on bit reset) instructions permit any bit in page 0 to be used as a flag. These are 3-byte instructions, with the op code in the first byte, the page-0 address of the byte containing the flag in the second byte, and the relative jump displacement in the third byte. Bits 6 through 4 of the op code give (in binary) the number of the bit within the page-0 byte to be tested. The processor reads the byte from page 0, checks the bit designated by the op code, and continues normal program flow if the designated bit is a 1. If it is a 0, a normal signed relative short branch is executed, using the third byte of the instruction for the offset. The BBSx (branch on bit set) instructions do the same thing except that they take the branch only if the referenced bit is set to 1.

The R65C02 includes a number of new instructions, making it more powerful than the standard 6502.

Unconditional Short Branch

The unconditional short-branch instruction (BRA) eases writing of position-independent code and in some cases allows shorter code. With the 6502, a sequence such as SEC (set carry), BCS (branch if carry set) is sometimes necessary to cause an unconditional position-independent jump. Even that sequence requires 3 bytes, as does a normal absolute jump (JMP). The BRA instruction permits an unconditional, position-independent branch requiring only 2 bytes.

Four new stack-manipulation instructions have been added to act on the X and Y registers. In 6502 programs, the X and Y registers could be pushed only by transferring them first to the A register. Thus, the normal sequence for saving the registers for an interrupt routine went something like this: PHA (push the A

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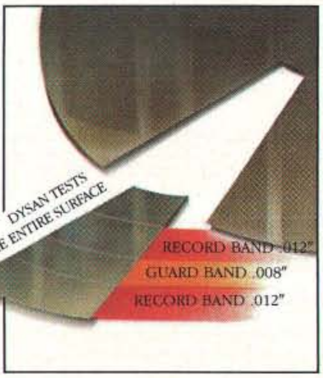

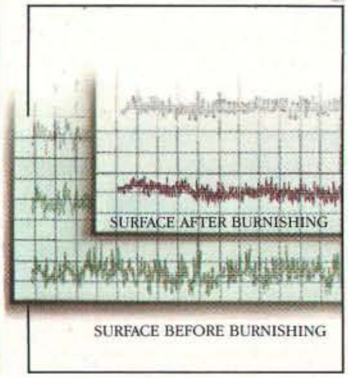

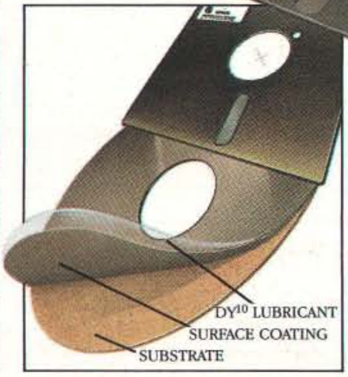

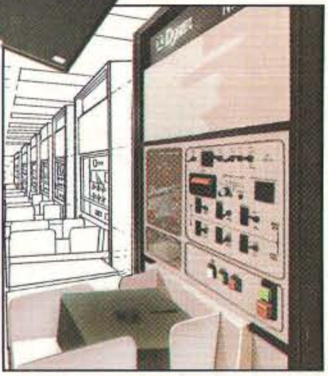

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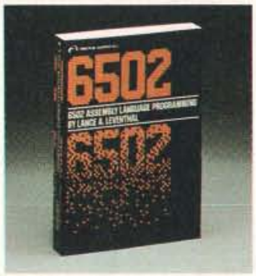

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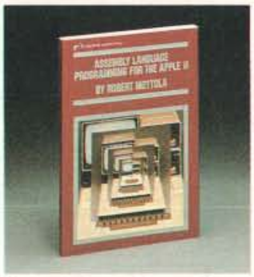

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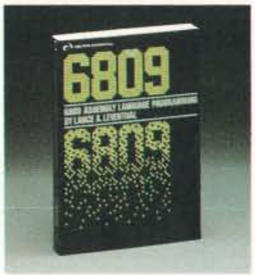

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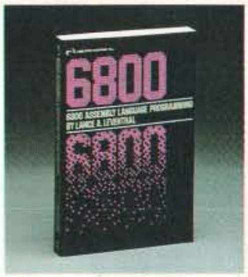

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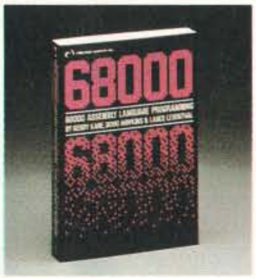

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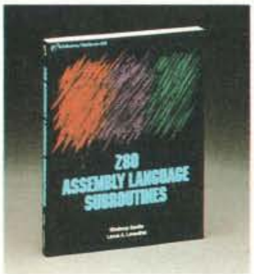

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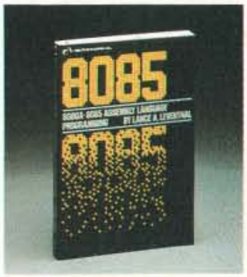

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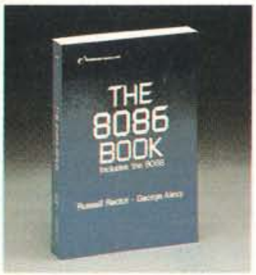

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register on the stack), TXA (transfer X to A), PHA, TYA (transfer Y to A), PHA. This sequence required extra time and memory and also made it difficult for a routine to save and restore all the registers and make use of a value passed to it in the A register. The four new instructions permit direct pushing and pulling of both the X and Y registers.

Set and Clear Page-0 Bits

Companions to the BBRx and BBSx instructions, the RMBx (reset-memory bit) and SMBx (set-memory bit) instructions permit setting and clearing single-bit flags in page 0 without affecting any internal processor registers accessible to the programmer. As before, bits 6 through 4 of the op code specify which bit is affected, and the second byte of the instruction specifies the page-0 location affected.

The new STZ (store zero) instruction permits zeroing an entire byte anywhere in memory without affecting processor registers. Four available addressing modes allow a 2-byte form for page-0 operations and a 3-byte form for general addresses, either of which may be indexed by the X register.

The TRB (test and reset bits) instruction is a composite of the 6502 BIT (bit test) and AND (logical and) instructions. The N (negative) flag is set to the value of bit 7 of the referenced memory location, and the V (overflow) flag is set to the value of bit 6. A logical AND is then performed between the referenced memory location and the A register, with the result stored into the memory location (A is unaffected), and the Z (zero) flag is changed to indicate the result of this operation (set if the result is 0, reset if it is nonzero). Note that, just as on the 6502, the N and V flags pertain to the value in memory *before* the AND operation takes place. The TSB (test and set bits) instruction is similar except that a logical OR is substituted for the logical AND operation.

Addressing Modes

In addition to totally new instructions, the R65C02 enables some existing addressing modes to be used with instructions that did not accept those modes on the original 6502. It also adds an entirely new addressing mode usable with a number of present instructions that should prove useful in making better use of the processor registers.

The 6502 has no simple indirect-addressing mode other than the JMP instruction. With no 16-bit registers to hold addresses, 6502 programs frequently keep addresses in page 0, especially when passing addresses to and from subroutines. However, the only way to use those addresses to access the data to which they point is through the pre- or post-indexed indirect-addressing modes. Thus, a common sequence in programs consists of loading the Y register with 0, followed by an operation using the "indirect, indexed by Y" addressing mode. Not only does this sequence result in extra code requiring additional memory space and execution time, but it ties up the Y register, which might be better used in other ways.

The R65C02 includes a simple indirect-addressing mode using a 2-byte address.

The R65C02 corrects this deficiency by adding a simple indirect-addressing mode, which uses a 2-byte address stored in page 0. This addressing mode can be used with all the major accumulator instructions: ADC (add with carry), AND (logical and), CMP (compare memory with accumulator), EOR (logical exclusive-or), LDA (load accumulator from memory), ORA (logical inclusive-or), SBC (subtract with borrow), and STA (store accumulator to memory).

New Modes for BIT

The BIT (bit test) instruction of the 6502 is severely limited in addressing modes. This instruction accepts only two modes: absolute (direct) and 0 page. Because this instruction functions as a logical AND except that the result is discarded, it is normally used to test flags. Most such tests would be most conveniently done with an immediate addressing mode, which is not permitted. Instead, 6502 programs must use a backward form of logic, loading the test mask using the immediate mode and then doing the test on the data directly from memory.

The R65C02 BIT instruction permits additional addressing modes—immediate, 0-page indexed, and absolute indexed. These added modes cover the vast majority of the situations in which this instruction would be used.

Increment and Decrement Accumulator

Arithmetic on the X and Y registers is not permitted by the 6502; neither is incrementing or decrementing the accumulator. Though such a need is rare, it does arise, and the lack of an accumulator-addressing mode for the increment and decrement instruction results in various kludges to get the desired result. Three alternate ways are commonly used. The most obvious is to use the ADC (add with carry) instruction to add an immediate value of 1. Because the 6502 does not provide a simple "add" instruction (without carry), this alternate method also requires a preceding CLC (clear carry) instruction, unless the state of the carry bit from prior operations is known. Alternatively, setting the carry bit followed by adding an immediate value of 0 accomplishes the same thing.

If the X or Y registers are not in use at the particular point in the program, it is possible to transfer the value from the A register to one of those registers and take advantage of the increment or decrement instructions for X and Y. A third method, most commonly used when the next step is to store the accumulator value in memory, is to store the A register value first and then increment it in memory, because the INC (increment) and DEC (decrement) instructions accept several different addressing modes for operations directly on data in memory.

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The R65C02 eliminates all of this foolishness by allowing the accumulator-addressing mode to be used with the increment and decrement instructions, enabling them to operate on all three of the general-purpose registers.

Hardware Factors

The R65C02 has the electrical characteristics you would expect from the current generation of CMOS integrated circuits. Versions for speeds to 6 MHz will probably be available. Power consumption is low and varies with speed, as is normal for CMOS technology. With the clock stopped, 10 μW power consumption is listed as maximum. Maximum power consumption in normal operation is listed as 4 mA (20 mW) per MHz, making battery-powered operation feasible when this chip is combined with the new CMOS memory chips.

Rockwell claims that the basic R65C02 version is pin and software compatible with the 6502. Another version, the R65C102, can generate all clock signals on-chip; it needs only an external TTL (transistor-transistor logic) level single-phase clock input (as does the 6502) or an external RC network or crystal. It also has a quadrature clock output, which is not provided by the 6502. This clock goes high in the middle of the phase-1 clock and returns low in the middle of the phase-2 clock.

The 6502 has not been commonly used in applications requiring multiple processors or direct-memory access, largely because it cannot float its address bus. Both the R65C102 and another version, the R65C112, have signals to permit bus sharing. The bus-enable (BE) signal permits an external device to cause the processor to float the address and data buses and the R/W signal, permitting access to the system buses. To prevent bus arbitration from interfering with read-modify-write instructions such as shifts and increments, a memory-lock (ML) output signal is provided to notify external devices that the processor cannot relinquish the bus until completion of the instruction. The R65C112 is designed to be used as a slave processor, requiring a two-phase clock input that would be generated by the system master processor.

Summary

The CMOS version of the 6502 chip fills in a number of gaps in the 6502 instruction set in addition to adding the obvious advantages of CMOS technology. The characteristics of the new chip permit the 6502 to expand in both directions into areas that were previously impractical. Completely battery-powered systems are now feasible for small, dedicated applications. Additionally, the added bus control permits multiple-processor systems and sophisticated direct-memory-access schemes to be used with this processor.

Perhaps the most impressive feature of the CMOS version is complete compatibility with the 6502 specifications, permitting the enormous base of 6502-based hardware and software to be used with the newer processor. The R65C02 processor represents a step above the 6502 similar to the step from the 6800 to the 6502, without the accompanying compatibility problems. The current popularity of 6502-based personal computers provides a large market for new applications of this processor.■

An Assembler for the R65C02

HEXASM is a full-feature resident assembler that supports the R65C02 microprocessor's extended instruction set. In addition to including such features as macros, conditional-assembly, and source-file-chaining functions, it can optionally be configured to either accept or reject constructs that are unique to the R65C02. HEXASM runs under HEXDOS on Ohio Scientific's OSI C1P and is available for $38.50 from Hx Computer Products, Route 8, Box 81E, New Braunfels, TX 78130 or The 6502 Program Exchange, 2920 West Moana, Reno, NV 89509.

Steve Hendrix, an instructor pilot for the U.S. Air Force, has a B.S. in computer science and mathematics from the USAF Academy. He can be reached at Route 8, Box 81E, New Braunfels, TX 78130. His hobbies include computers and astronomy.

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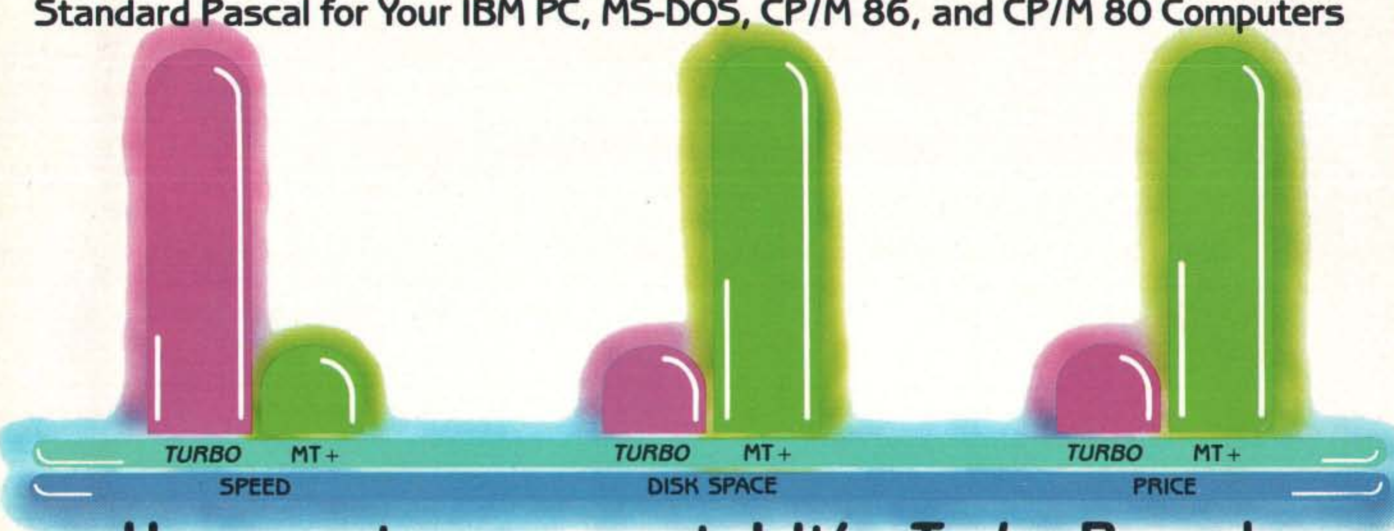

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A Tiger Meets a Dragon

An examination of the mathematical properties of dragon curves and a program to print them on an IDS Paper Tiger printer

by Dan Rollins

Martin Gardner's "Mathematical Games" column in *Scientific American* (now Douglas Hofstadter's "Metamagical Themas" column) was a treasure chest of ideas for computer hobbyists. A few years ago Gardner described a computer-plotted example of a design he called a *dragon curve* (see figure 1). If you use your imagination you can see the resemblance to the classic oriental dragon—hence its name. Donald Knuth, mathematician and computer scientist, has done a great deal of work documenting the significance of the dragon-curve design and its relationship to number theory. Knuth was so impressed with the design that he reproduced it in ceramic tiles for the entryway of his home.

Fascinated by the beauty of dragon curves and intrigued by their binary nature, I wanted to create such designs to adorn my own walls. I wrote two programs for my TRS-80 Model I to output the design to my IDS Paper Tiger printer: a curve generator and a plotter emulator. In this article I will describe the theory of the dragon curve, methods of its construction, and its relationship to the broader generalized dragon design. I will also describe how to use TRS-80 disk memory to enhance the graphics potential of the IDS Paper Tiger, enabling it to work like a plotter to fill an 8½- by 11-inch printer page with high-resolution figures.

Constructing the Dragon Curve

Dragons are designated by size, or *order*, of the dragon curve. There are several ways to construct these designs. The first two methods I describe will help you visualize the procedure. The latter two are algorithms suitable for computer programming.

Folding the paper using any arbitrary sequence of directions will generate a line with the properties of a classical dragon curve.

A way to define a dragon design geometrically is shown in figure 2. Start with a large right angle. This is an order-1 design. Erase part of the two line segments and replace each with smaller "folds" that intersect at right angles to create an order-2 design. To build larger dragon curves, follow the same procedure using the previously defined design. At each step, replace n straight lines with n right angles to create an order-$n + 1$ dragon.

Another way to generate simple, low-order dragons is to fold and refold a narrow band of paper. This idea was the basis for physicist John E. Heighway's discovery of the dragon curve. Visualize a flat strip of cash-register tape—an order-0 dragon curve. Fold it once in the center, and you have an order-1 dragon. Bisecting the tape by folding it n times, always in the same direction, will create an order-n dragon curve (see figure 3). Because this operation will divide the paper into $2n$ areas, an unfolded order-n tape will have 2^n-1 right-angle creases. (An old saw says that regardless of its thickness and length, no strip of paper can be folded more than seven times, but for this discussion, we will ignore this physical restriction.)

Now unfold the tape so that the creases form 90-degree angles. The unfolded tape will have a pattern of left and right turns that wind around in seemingly random directions. The dragon sequence is easier to describe when we designate a left turn as L, a right turn as R, and give the name S to the typographical string (the L,R sequence). If we choose L as the direction the tape bends on its first

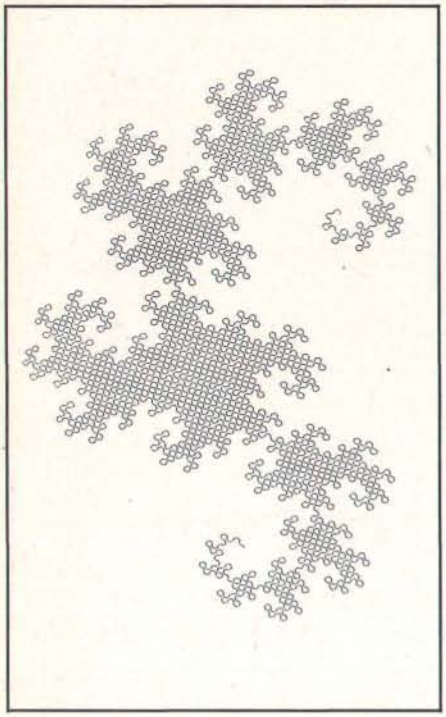

Figure 1: *An order-12 classical dragon curve. This dragon curve was constructed on a TRS-80 Model I using the Gendragn program. It was printed on an IDS Paper Tiger, used with the Diskplot print routines as a plotting device.*

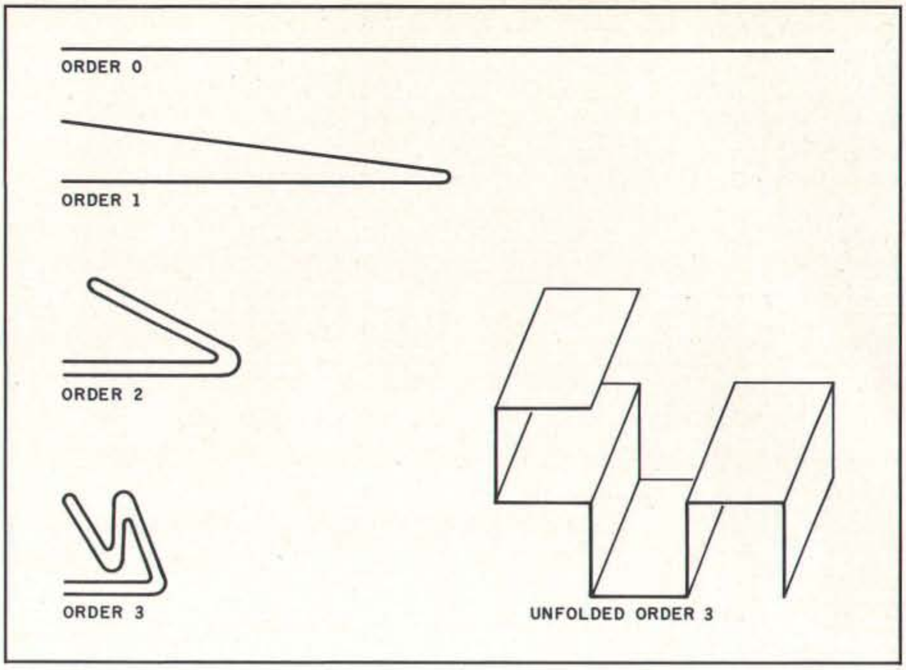

Figure 3: *The paper-tape method of construction.*

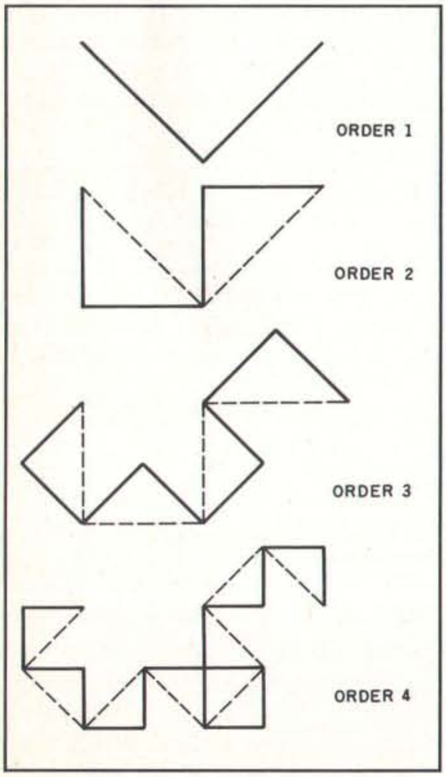

Figure 2: *The geometric method of constructing dragon curves. Note that the side of dragon curve order-n becomes the hypotenuse of order-n+1.*

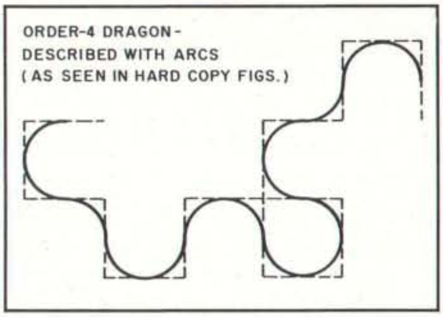

Figure 4: *An order-4 dragon "rounded off" using (quadrant) arcs at every 90-degree angle. Compare to figure 1. The output of Diskplot uses this procedure.*

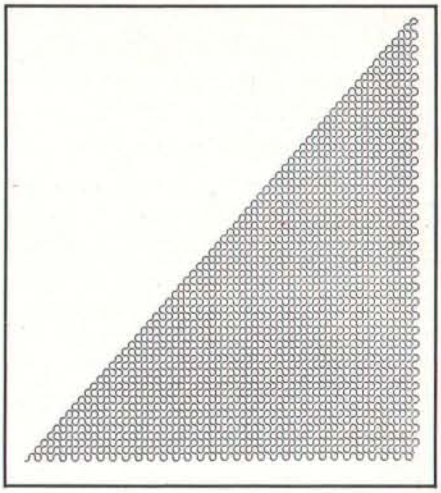

Figure 6: *Folding the paper tape alternately left, then right, forms this isosceles dragon.*

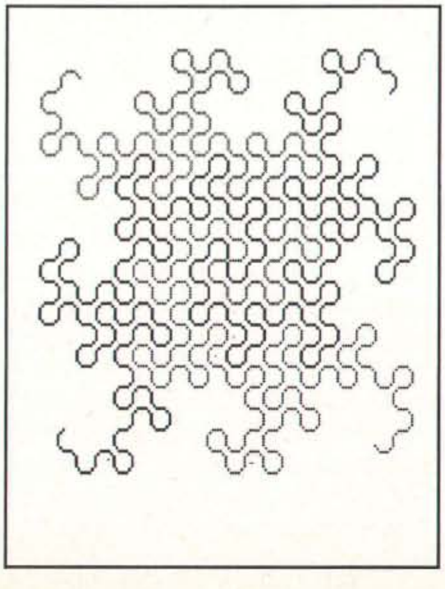

Figure 5: *Four order-7 dragons placed "tail to tail."*

fold, the lowest-order strings are described as follows:

S(1) = L
S(2) = LLR
S(3) = LLRLLRR
S(4) = LLRLLRRLLLRRLRR

Building dragon sequences with a computer is a matter of manipulating the L,R strings. Notice that S(n+1) is a superset of sequence S(n). The emerging pattern can be extrapolated by either of the following recursive techniques:

Algorithm 1: To S(n), add an L. Then add the string obtained by inverting the center character of S(n); that is, if the center character is an R, make it an L and vice versa. Thus, because S(2) is LLR, S(3) is made up of LLR + L + LRR.

Algorithm 2: Add an L to S(n), then add the inverted and reversed sequence $\overline{\mathrm{S}(n)}$. For example, because S(3) = LLRLLRR, its inverted form is RRLRRLL. Rearranging these characters so that the last is first and the next to last is second, etc., creates the string LLRRLRR. So S(4) is S(3) + L+ $\overline{\mathrm{S}(3)}$ or LLRLLRR + L + LLRRLRR. The result is akin to placing two order-n dragons snout to snout, producing the order-n+1 dragon. Symbolically, this algorithm most closely resembles the folding of the cash-register tape and is the method used in listing 1, the BASIC dragon-generating program (Gendragn).

The dragon generated by either of these algorithms will have some interesting properties: the line representing any order dragon will never cross itself; any point along the tracing grid will be touched by at most two bends of the line, and no line segment will ever be traced twice. This is easiest to see when the corners of the bends are rounded (see figure 4).

Figure 5 illustrates a significant topographical property of dragon curves. That is, that an order-∞ design will cover exactly one-quarter of the infinite plane (OK, one-quarter of ∞ *is* ∞, but never mind that); four such dragons joined at their tails (see the center of figure 5) will fill the infinite plane without crossing one another.

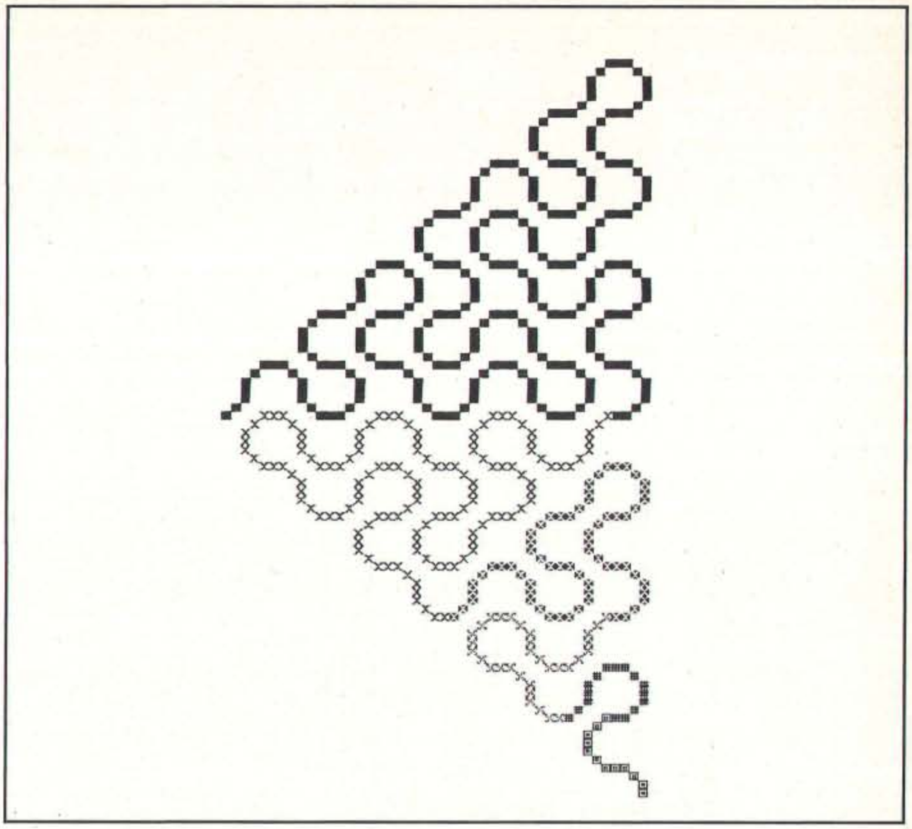

Figure 7: *An illustration of the recursive nature of the isosceles dragon. Each triangle is made up of combinations of smaller triangles.*

The Generalized Dragon Curve

Until now we've discussed only the "classical dragon curve," the figure drawn when the cash-register tape is always folded over to the left. It is easy to see that folding always to the right produces a mirror-image of the classical dragon (the "head" is the "tail" and vice versa). An alternating sequence of directions can also be used in the folding process. Figure 6 is a drawing of an order-12 "generalized dragon" when the first fold is to the left, the second to the right, the next to the left, etc. After the apparent randomness of the classical dragon, this one may come as a surprise. However, note the standard dragon features: the design will fill one-quarter of the plane, and it never crosses over itself. Figure 7 is an order-5 dragon with this LRLRL direction-reversal sequence. The recursive nature of this beast was illustrated by changing the dot pattern at each step of the inversion process.

Going one step further, it can be proven that folding the paper using *any arbitrary sequence of directions* will generate a line with the same draconic properties. (See reference 2 for the elegant proof formulated by Davis and Knuth.) There are, of course, an infinite number of such combinations, some of them quite intriguing.

Given a direction-reversal sequence:

$$\mathrm{DRS} = d_1\ d_2\ d_3\ d_4\ .\ .\ .\ d_n$$

the generalized dragon is constructed by the formula:

$$\mathrm{S}(n) = \mathrm{S}(1) + d_1 + \overline{\mathrm{S}(1)} + \mathrm{S}(2) + d_2 + \overline{\mathrm{S}(2)} + \ldots + \mathrm{S}(n-1) + d_n + \overline{\mathrm{S}(n-1)}$$

Figures 8 and 9 are dragon curves generated using the randomly selected direction-reversal sequences printed beneath each. These generalized dragon curves piqued my curiosity enough that I wrote a BASIC program to generate and draw

Listing 1: *The program Gendragn, written in TRS-80 Disk BASIC.*

```
5 '**
   **                    GENDRAGN
   **               written by Dan Rollins
   **                    4/29/82
   **
6 '**
   ** Creates a "generalized" or "classical" dragon curve.
   ** Use with DISKPLOT subroutines or modify for
   ** high-res video plotting.
   **
10 CLEAR 25000 :DEFINT A-Z '** clear less if Out of Memory
20 GOSUB 3000     '** initialize disk plotter variables
30 CLS :PRINT@ 71," Generalized Dragon Curve Generator"
40 PRINT@ 140,"programmed by Dan Rollins"
50 PRINT :INPUT "size (order ) of dragon curve";N
60 PRINT :PRINT"input Direction Reversal Sequence"
70 PRINT"(string of Ls and Rs ... Example: LLRRLRRR )"
80 PRINT"enter 'G' to generate a random sequence"
90 PRINT"default= 'L' (the classical dragon curve)"
100 LR$="L" :INPUT LR$ :IF LR$<>"G" THEN 140
110 LR$="" :FOR J=1 TO N
120   IF RND(2)=1 THEN LR$=LR$+"L" ELSE LR$=LR$+"R"
130 NEXT :PRINT "direction reversal sequence: ";LR$
140 L=LEN(LR$) :LAST=2↑N-1 :DIM D(LAST+1)
150 SC=2
     :INPUT"scale (1 - ??, default=2)";SC :IF SC<1 GOTO 150
160 PRINT :QA$="Y"
     :INPUT"automatically center dragon curve (Y/N)";QA$
170 CLS :PRINT :PRINT "** generating the dragon sequence **"
180 SP=1 :IP=1 :IF LEFT$(LR$,1)="L" THEN D(1)=1 ELSE D(1)=-1
190 FOR J=2 TO N
200    IP=IP+1 :IF IP>L THEN IP=1
210    IF MID$(LR$,IP,1)="L" THEN IN=1 ELSE IN=-1
220    D(SP+1)=IN                        '** add DRS fold
230    FOR K=1 TO SP
240       D(2*SP+2-K)= -D(K)             '** invert prior folds
250    NEXT
260    SP=SP*2+1
270 NEXT
280 DX(2)=1 :DX(4)=-1 :DY(1)=-1 :DY(3)=1
290 IF QA$="Y" GOTO 320
300 SX=248 :SY=360 :D=1
     :INPUT "starting point (X,Y)";SX,SY
     :INPUT "starting direction:
     (1)=North, (2)=West, (3)=South, (4)=East";D
310 IF SX<0 OR SX>496 OR SY<0 OR SY>P9 OR D<1 OR D>4
      THEN 300 ELSE 460
320 SX=0 :SY=0 :D=1 :SD=1 :XH=-1 :XL=1 :YH=-1 :YL=1
330 PRINT :PRINT"** Centering **"
340 FOR J=1 TO LAST
350   SX=SX+DX(D) :SY=SY+DY(D)
360   IF SX<XL THEN XL=SX ELSE IF SX>XH THEN XH=SX
370   IF SY<YL THEN YL=SY ELSE IF SY>YH THEN YH=SY
380   D=D-D(J) :IF D<1 THEN D=4 ELSE IF D>4 THEN D=1
390 NEXT
400 XH=XH*(4+SC) :XL=XL*(4+SC) :YL=YL*(4+SC) :YH=YH*(4+SC)
410 XD=XH-XL :YD=YH-YL
420 IF YD>496 AND XD>496 THEN
   PRINT USING"PLOT WON'T FIT! it's #### wide,#### high";XD,YD
      :INPUT"(D)EFINE START OR (N)EW DRAGON";QA$
      :IF QA$="D" GOTO 300 ELSE IF QA$="N" THEN RUN ELSE 420
430 SX=(496-XD)/2-XL :SY=(P9-YD)/2-YL
440 IF XD>YD AND P9>496
     THEN SD=2 :SX=(496-YD)/2+YH :SY=(P9-XD)/2-XL
450 '**
     ** following code interprets the dragon sequence,
     ** plotting the folds
     **
460 X=SX :Y=SY :D=SD :CLS
470 FOR J=1 TO LAST
480    FOR K=1 TO SC
490       X=X+DX(D) :Y=Y+DY(D) :GOSUB 1500 '** plot X,Y
500    NEXT
510    D1=D
520    D=D-D(J) :IF D<1 THEN D=4 ELSE IF D>4 THEN D=1
530    FOR K=1 TO 2
540       X=X+DX(D1)+DX(D):Y=Y+DY(D1)+DY(D)
550       GOSUB 1500                       '** plot X,Y
560    NEXT
570    PRINT@ 196,USING "remaining folds to plot: ####";LAST-J
580 NEXT
590 GOSUB 4000   '** close the file
600 GOSUB 5000   '** print the file
610 LPRINT
620 LPRINT TAB(34);"order ";N;" Dragon Curve"
630 LPRINT TAB(30-L/2);"Direction Reversal Sequence:  ";LR$
640 IF L=1 THEN LPRINT TAB(30)".........Classical Dragon Curve"
650 CLS :PRINT :INPUT" print the Same or a New curve (S/N)";A$
660 IF A$="N" THEN RUN ELSE IF A$<>"S" THEN 650
670 INPUT "press <ENTER> when printer is ready";QA$ :GOTO 600
```

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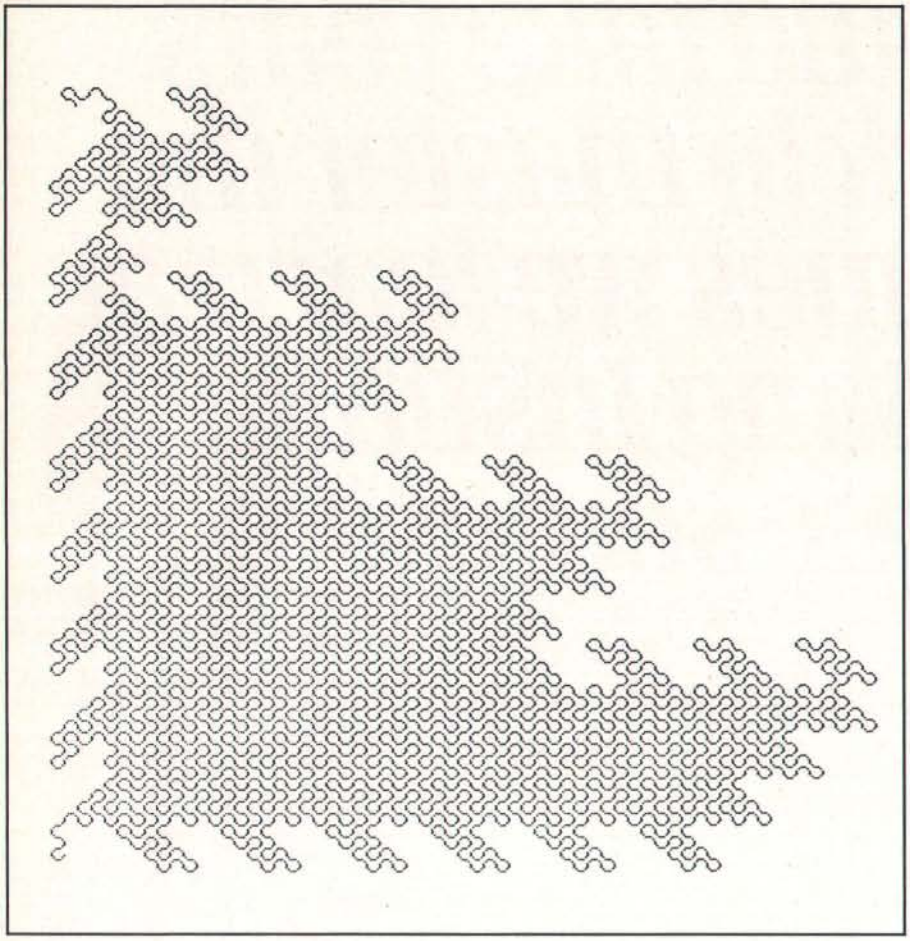

Figure 8: *A nonclassical order-12 dragon, using the arbitrary sequence LRRRRLRRLR entitled "Four-Alarm Fire."*

them. The program that builds the dragon sequence is relatively simple.

Computer Dragons

Listing 1 generates the dragon sequence and then interprets it as movement of an *x,y* pointer. The coordinate pairs generated may be used to draw on a video screen or move a pen around a plotter surface. I used this program in conjunction with the Diskplot routines (listing 2, described later) to produce the examples included with this article. Only a few minor modifications are needed to have the output sent to the TRS-80 Color Computer screen or another high-resolution device.

First the program asks for the order of the dragon to be drawn. You are then asked to input the direction-reversal sequence—the string of Ls and Rs mentioned earlier. Answering <G> generates random dragons such as those in figures 8 and 9. Answering <ENTER> or <L> or <R> will generate a classical dragon curve. The SCALE? prompt determines the length of the line segments between the folds.

The dragon sequence is held in an integer array as a series of positive and negative 1s. Once this series has been generated, the program adds each successive value to a direction pointer that references a table holding the *x,y* offsets needed to move the "pen" in the desired direction. Figure 10 shows how this is accomplished. When the current direction is 1 (north) and the fold is to the left (counterclockwise), the direction pointer is adjusted to point to the west, the number-4 direction. Adding −1 to the current direction in this case will yield an underflow value of 0. Whenever underflow or overflow is indicated, the algorithm cycles the pointer to the correct value.

The line segments are drawn by repeatedly adding the *x* and *y* offsets found in the direction table to the current value of the *x,y* pointer and plotting the dot at the new location. The program doesn't actually draw a curve at each fold. Instead, a corner of the fold is simply chopped off by moving simultaneously in both the old and new directions.

To prevent the dragon from moving off the page, the program will automatically center the design before drawing it. This is done by making a "dry run" through the design, accumulating the high and low values of the *x* and *y* coordinates generated. When the dragon won't fit horizontally, it is rotated by initializing the starting direction differently and recalculating the starting *x* and *y*. This centering function is device dependent in that the page size (length and width) are those values used by the Diskplot plotter emulator.

TRS-80 Model I video resolution is only fine enough to display dragon curves of order 5 and below. After experimenting with the algorithm for a while, I began craving the 5000+ dots-per-square-inch resolution available on my Paper Tiger printer.

Tiger Graphics

The IDS Paper Tiger graphics option gives the user complete control over the placement of dots on a printed page. High-resolution graphics patterns are displayed by selectively energizing the print-needle pins as the print head moves across the page.

The printer enters graphics mode the first time it receives the ASCII (American National Standard Code for Information Interchange) control character ETX (hexadecimal 03). Thereafter it interprets characters as binary-dot patterns. The bits of the printed byte indicate the *fire/don't fire* decision for each of the seven pins of the print head. Bits 0-6, set in the output byte, energize the pins from top to bottom, respectively. Thus, a CHR$(127) is printed as a vertical line of seven dots. To print the top and fourth dots, for example, send CHR$(9)—setting bits 0 and 3.

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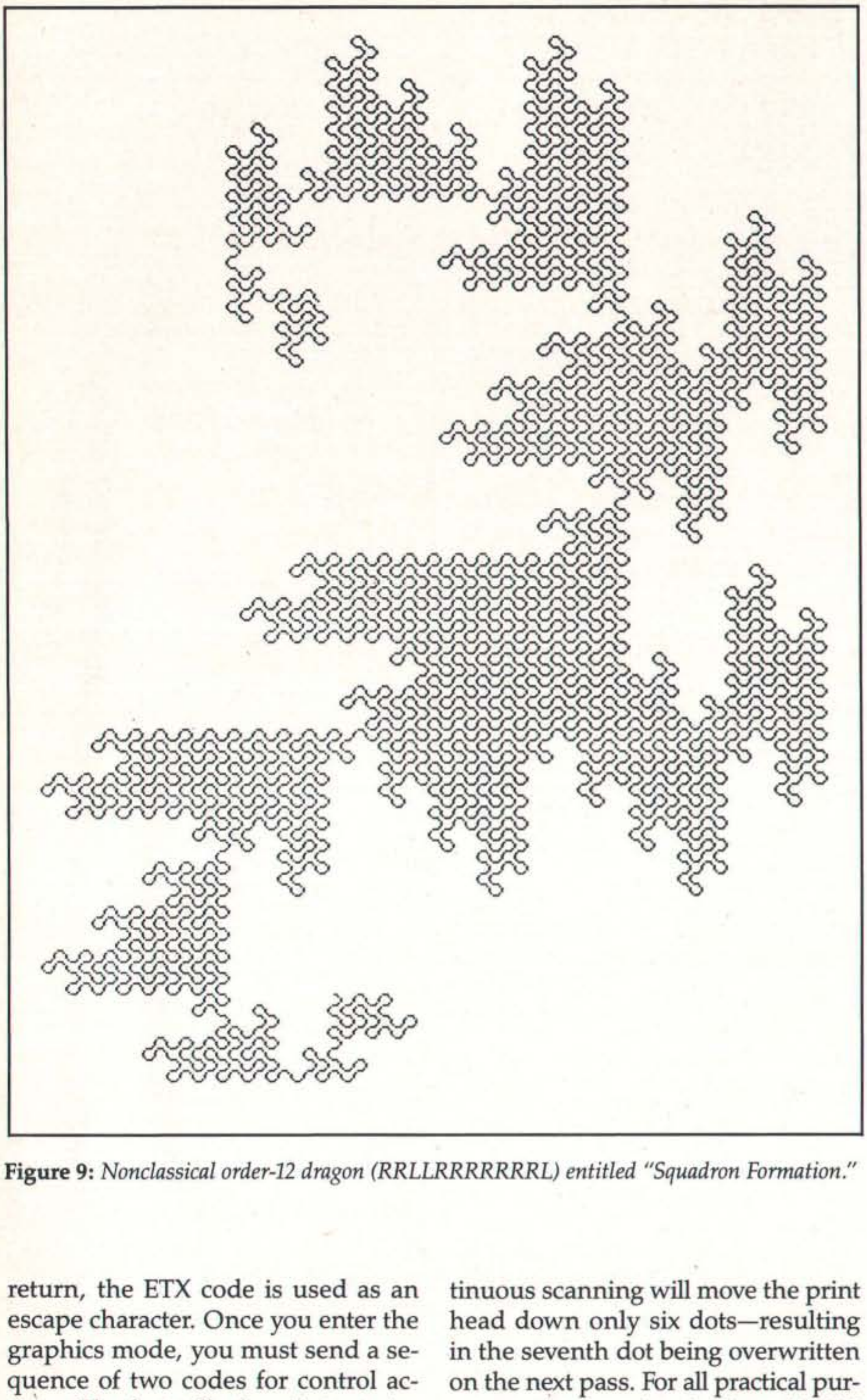
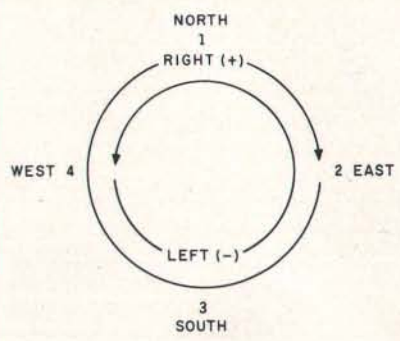


Figure 9: *Nonclassical order-12 dragon (RRLLRRRRRRRL) entitled "Squadron Formation."*



DIRECTIONS	X-OFFSET	Y-OFFSET
NORTH	0	−1
EAST	+1	0
SOUTH	0	+1
WEST	−1	0

Figure 10: *The "pen" is moved by adding offsets to an x,y pointer. The directions pointer is cycled according to the L,R sequence of the dragon.*

return, the ETX code is used as an escape character. Once you enter the graphics mode, you must send a sequence of two codes for control actions. The first tells the printer to interpret the second as a control action. CHR$(3); CHR$(11), for example, forces a vertical tab (graphics linefeed and carriage return). The sequence CHR$(3); CHR$(2) exits graphics mode, forcing resumption of normal mode. To print the graphics character 3—firing the top and second pins—print the ETX twice: CHR$(3); CHR$(3).

While all seven dots may be printed, the vertical tab used in continuous scanning will move the print head down only six dots—resulting in the seventh dot being overwritten on the next pass. For all practical purposes, then, only six dots (ASCII characters 0 through 63) can be printed per line. Also, bit 7 is ignored by the printer in any mode.

Interfacing the Paper Tiger with a TRS-80 can be a trifle confusing. Certain codes that have had LPRINT performed on them while in graphics mode produce bizarre results. The problem lies in Radio Shack's LPRINT driver. The Level 2 BASIC firmware filters out some codes; it simply will not print them. Other characters are interpreted undesirably. The graphics data byte CHR$(12), for example, is printed as a series of CHR$(13) carriage returns, a "soft" formfeed. Any graphics LPRINT string that contains a CHR$(12) will print a series of characters with the first, third, and fourth bits set—not quite what you had in mind.

My solution to this problem is to perform an OR on a value of 128 (80 hexadecimal) to each byte sent to the printer. This setting of bit 7 does not alter the way the graphics codes are printed and the LPRINT driver won't intercept or change such characters. Another method of solving this problem is to write your own printer driver.

My Paper Tiger, Model 440-G, lacks some of the options of the newer models: printing is unidirectional and there is no proportional spacing. The graphics feature, however, is compatible with all models that have graphics capabilities. Only three of the dot-spacing fonts (8.3, 10, and 12 characters per inch in normal mode) may be used for graphics output. The manual suggests that the 16.5-cpi font be avoided due to excessive print-head heat buildup. Also, graphics characters sent in this character density tend to not line up evenly.

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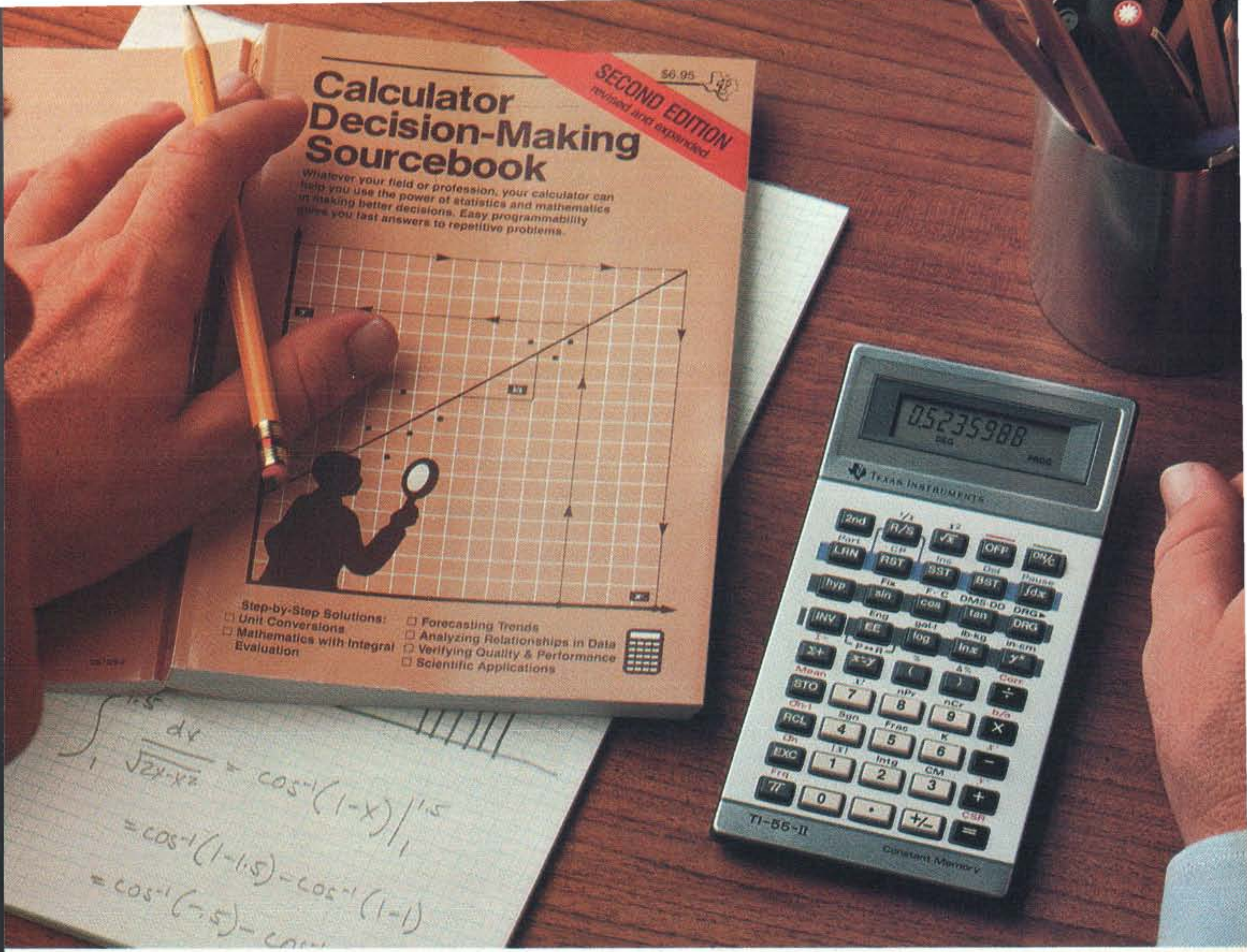
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mode yields the best horizontal-to-vertical dot-spacing ratio. In this mode, 496 bytes can be printed across the page. A box 496 by 496 covers an area 7.7 inches wide by 6.9 inches high. The printer can print 120 lines on an 8½-by-11 sheet of paper. With a ½-inch border on each side, the effective resolution is 496 by 720.

A Plotter Emulator

Many printer manufacturers describe their product as having "graphics capability," but getting recognizable graphics from a dot-matrix printer is tricky. Programs written for generating video or plotter graphics invariably employ a two-dimensional coordinate system. That is, given a horizontal *x* ordinate and a vertical *y* ordinate, a video program will perform a SET on that position, making it visible. A plotter will perform a MOVE on a pen to the given coordinate from its last position, drawing a line as it goes. Neither action corresponds to what goes on in dot-matrix printing.

The graphics potential of your dot-matrix printer can be realized when a control program is used to emulate the actions of a plotter. Because the printer can't physically move the paper up and down under the print head, this action must be simulated by a program that writes to memory.

A simple version of such a program would create a two-dimensional integer array, set each element to 0, then move an *x,y* "pointer" around the matrix setting the indicated elements to 1 as it goes. After this "plotting" is finished, a separate routine is needed to examine the array six lines at a time, to build the characters expected by the printer.

While this method may be the easiest to work with, it is enormously wasteful in terms of memory—an integer array of only 125 by 125 would occupy all of the approximately 32K bytes of available memory. And the print routine would be laborious. A more sophisticated program, one using all 16 bits of each array element, could store 256K dots (an array of, say, 500 by 500) again at the expense of processing time for both the plotting and printing routines. Also, when most of the computer's memory is preempted by a printer array, the application program may be hard pressed for its own storage needs.

The Paper Tiger can place over 350K dots on a page. I needed almost every one of these points to print the order-12 dragon seen in figure 1. To be able to access every potential dot on the page, I wrote Diskplot, a set of multipurpose plotting and printing routines that use disk storage interactively with memory—a virtual-memory plotting system.

The idea of virtual memory has been around about as long as disk drives have been interfaced with computers. The concept is simple. While memory tends to be severely limited, there may be plenty of storage available on disk. A virtual-memory management system allocates to the user a block of RAM (random-access read/write memory) and a larger block of disk memory. When the user's program or data won't all fit into the RAM area, it is broken into segments or "pages." The page currently being accessed by the computer processor unit is held in RAM. When a different page is needed, the system saves the old page (invisibly to the user) and brings in the new one from the disk. The user may access memory as if the entire block was always in memory.

A virtual-memory operating system requires a translating or "mapping" algorithm to keep track of which page is in memory and to adjust the virtual addresses to reflect the actual RAM addresses. When only one page is in memory, this algorithm can be simple. However, the system becomes more complex (and more useful) when several pages are held in memory at the same time. In this case, the mapping algorithm should also have some sort of plan-ahead feature to anticipate which pages the user will need in future addressing.

The efficiency of the system is largely determined by the amount of time spent accessing the disk. The

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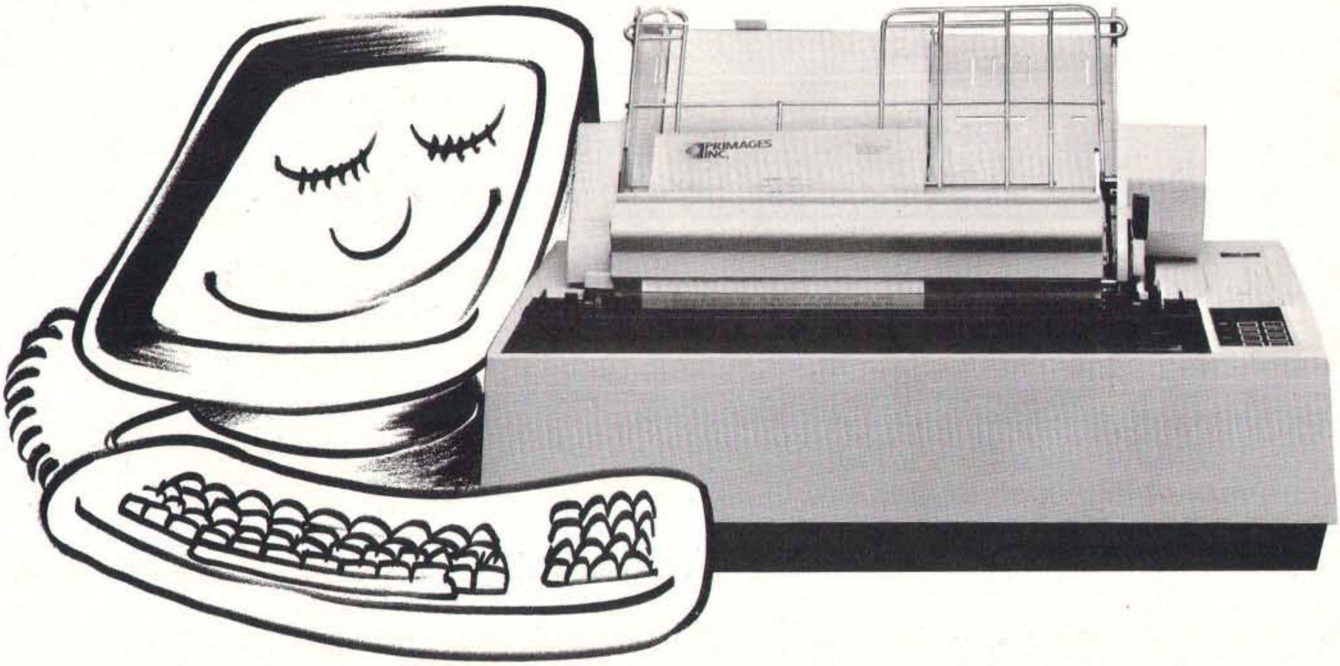
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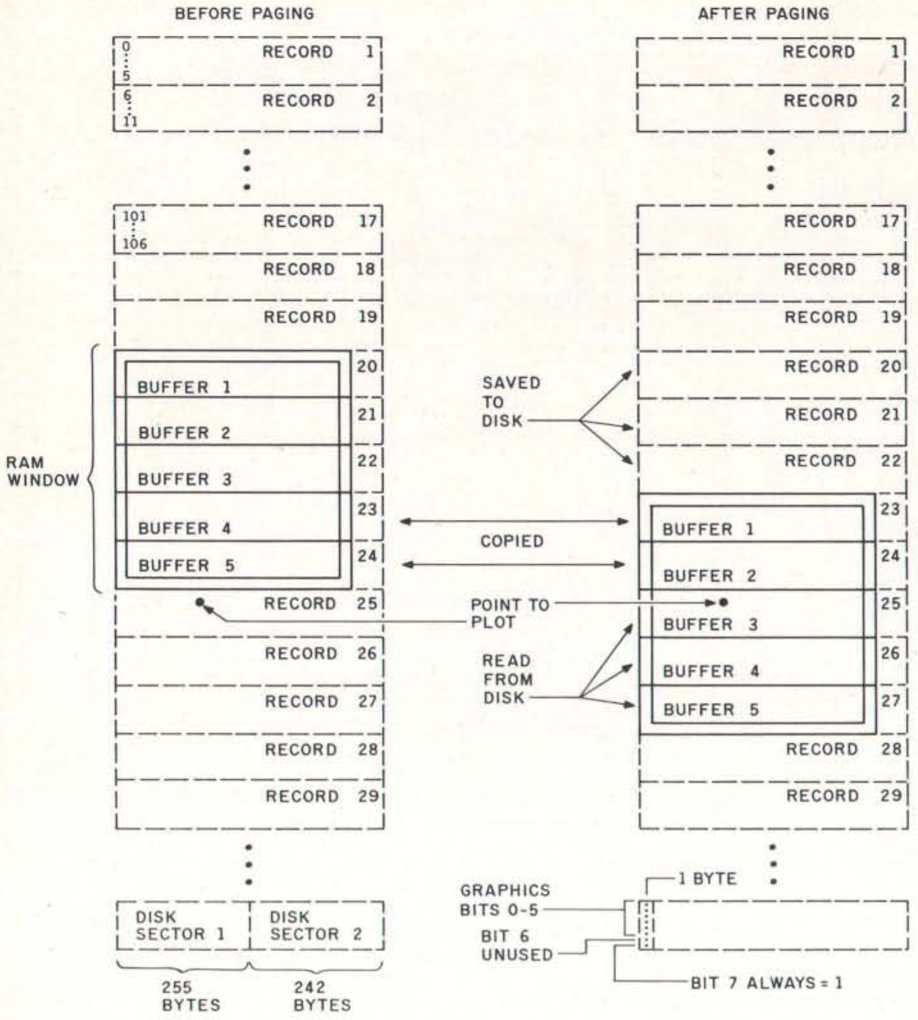

Figure 11: *The virtual-memory mapping algorithm used in Diskplot. Records are moved in and out of RAM buffers. When the "pen" is directed off the page (point to plot in record 25, at left), part of a new page is scrolled into memory.*

number of disk accesses may be limited by reading and writing a large number of pages, while the amount of time per access can be shortened by using a small number of pages. An optimum virtual-memory size will lie somewhere between all of main memory and a single disk buffer.

Radio Shack's (Microsoft) Disk BASIC includes all the tools necessary to implement these concepts on the TRS-80. Instead of packing bits into an integer array for later interpretation, I chose to build a random-access file to store the data on disk and use BASIC strings to hold the in-memory data. Standard GET and PUT commands scroll data in and out of memory, and no special VARPTR or POKE tricks are needed.

All data is stored as characters formatted for direct output to the printer. This method has both advantages and limitations. The main advantage is the speed of the printout. The disk sectors hold data that may be directly (with one exception) output to the printer. The printout routine is simple—read and perform an LPRINT on two sectors per output line. A pageful of graphics is output without waiting for BASIC to do a time-consuming conversion. The only exception occurs when an ETX data byte is encountered in the file. That byte must be printed twice. Typically the print head never halts its motion across the page. The graphics examples included with this article were each printed in less than two minutes.

As with many computer programs, the speed advantage is gained only at the expense of storage efficiency. Preformatting the data for printer output is inefficient in at least two ways. First, only 6 bits of any byte are seen by the printer, so 25 percent of each byte goes unused. Second, to stay compatible with TRSDOS, disk buffers must have an LRL (logical record length) of 255 bytes. (Theoretically, all 256 bytes are usable, but because the records are manipulated as strings and BASIC strings are only 255 characters long, the task becomes easier when the 256th byte is ignored.) Because a horizontal print line is 496 bytes wide, I use two 255-byte buffers for each. This means that 14 bytes at the end of the second disk buffer remain empty—another 3 percent loss of storage efficiency. If you use the NEWDOS80 or LDOS variable-length records, you can eliminate some of the waste.

Mapping Memory

Figure 11 illustrates the virtual-memory mapping algorithm I devised for Diskplot. Two random-access disk sectors contain the data for one printed line—six vertical (y) rows of 496 horizontal (x) columns. This 510-byte area is a *buffer* when it is in memory. The same two sectors are a *record* when they are on disk. For maximum flexibility, Diskplot allows a variable number of buffers.

The buffers are a "window" to the records stored on disk. This window is moved up and down within the file, according to the current position of the x,y pointer—the simulated plotter "pen."

The strategy for paging records in and out of the buffer area is as follows. Before any dot is plotted, the y ordinate is compared to the minimum and maximum y rows currently being held in buffers (the x ordinate need not be tested as all columns for a given y will be in memory). At some point the pen will be directed to move off the page—beyond the edge of the current viewing window. To accommodate the roving pen, the window is scrolled to a new position in the file, a position that places the pen at the center of

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the new page.

In figure 11, the user has chosen to use five buffers. The paging example begins with buffers 1 to 5 holding records 20 to 24. The calling program has directed the pen to write to record 25, which is not currently in memory. The window is moved down by first saving buffers 1, 2, and 3 to disk records 20, 21, and 22—scrolling these records out of the window. Then buffers 4 and 5 are copied to buffers 1 and 2. This action is the same as moving the higher numbered records to the lower numbered buffers; i.e., records 23 and 24 are placed into buffers 1 and 2. Finally, new records 25, 26, and 27 are read into buffers 3, 4, and 5—scrolling them into the window.

The top of the new page has been formed from the lower part of the old page. The bottom of the new page holds the data read from disk. The pen is then pointed to record 25 held in buffer 3, the center of the new page.

When widely separated *y* ordinates are sent consecutively to the subroutine and there is no page overlap, all the buffers are saved, and new records are read into them.

In this manner, every disk access is to contiguous records, minimizing disk I/O (input/output) time. Furthermore, after paging, the pen is left pointing to the center of the window; its meandering course is likely to remain on the page for a maximum length of time.

This strategy is ideal for drawing dragon curves and other designs that seldom lift the pen from the paper. It becomes less efficient when the plotting program lifts the pen often to move to widely separated points. Knowing how the records and buffers are accessed will speed up the drawing of many designs; i.e., points along the same *y*-axis may have widely separated *x* ordinates without slowing the plotting. Even though Diskplot eliminates spurious disk writes (it doesn't resave a buffer that hasn't been altered while in memory), erratic motion along the *y*-axis is bound to increase disk I/O, slowing the "plotter" considerably.

Garbage Collection

Because Diskplot uses character-string buffers for dot storage, it spends time manipulating strings. Microsoft string-manipulation commands are flexible and extensive, but the BASIC garbage-collection process is, at times, irritating. A program that uses a lot of string space will eventually invoke this function, which locks up the keyboard and halts the running program while reorganizing the string-storage area. String sorts that create a TEMP$ for each exchange are prime examples. The garbage collector is one reason such routines seem to take so long.

This problem has a little-known solution built into Disk BASIC. The "MID$=" assignment function is used to replace a portion of a destination string with a portion of a source string. MID$(DEST$,5,2)=SRC$ places the first two characters of SRC$ into positions 5 and 6 of DEST$. The last argument is optional with a default of moving the entire source string (or as much of it as will fit) into the specified positions of the

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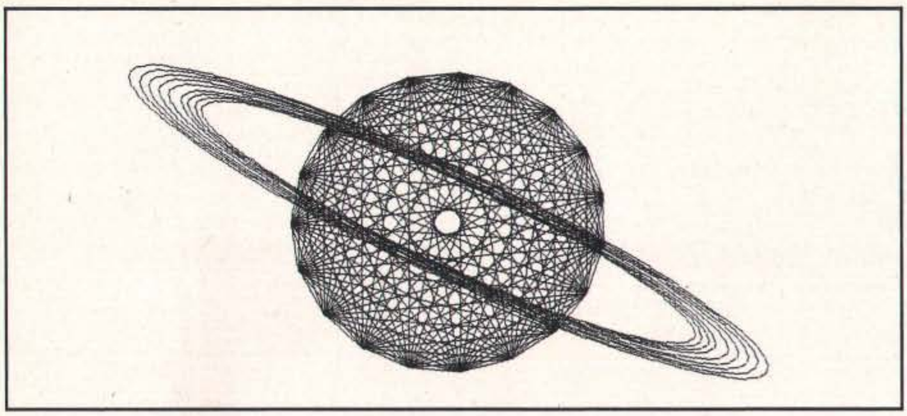

Figure 12: *A 19-vertex* n-*gon overlayed by concentric ellipses. Drawn with Diskplot.*

destination string. When DEST$ and SRC$ are the same length, invoking the function via

MID$(DEST$,1) = SRC$

replaces all characters of DEST$ with the characters of SRC$.

The effect is equivalent to the assignment: DEST$ = SRC$, with the exception that no new string memory has been used. Consequently, garbage-collection time is minimized. For sorting strings of the same length, in place of the line

T$ = A$:A$ = B$:B$ = T$

use

MID$(T$,1) = A$:MID$(A$,1) = B$
:MID$(B$,1) = T$

where T$ has already been assigned with a length the same as A$ and B$. The time savings is dramatic! The virtual-memory system controlling Diskplot uses this method for moving data from the FIELDed disk buffer to the virtual-memory buffers, in copying buffers when the window is scrolled, and when turning on a bit in a string buffer. Therefore, even though much of 32K bytes of string memory is constantly being manipulated, garbage collection is never involved.

Using Diskplot

Diskplot was written to be used in a variety of plotting applications. The subroutine package is a flexible alternative to expensive plotter hardware. Many plotter and high-resolution screen graphics programs can be easily converted for use with this program. Figure 12 was created by overlaying the output from Mike Higgins' plotter program (August 1981 BYTE, pages 414–416) with some elliptical circles that I devised. Only minor changes were needed for routing the output, via Diskplot, to my Paper Tiger.

Screen commands like PSET are implemented by assigning variables *x* and *y* with the desired coordinates and issuing a GOSUB to line 1500. LINE (or DRAW TO) commands are emulated with a GOSUB to 1000, preceded by assigning *x*1,*y*1 and *x*2,*y*2 with the start and end points of the line to be drawn.

Before running the application program, the string-storage area must be CLEARed and the initialization routine at line 3000 must be called. A series of inputs inquires about page length (the expected maximum *y* ordinate), the number of buffers desired, and the filename for the disk-plotter image file.

The calling program should perform a CLEAR on string space in proportion to the expected number of buffers. Each buffer requires 510 bytes of string memory. The dragon-curve generation program (listing 1) CLEARs enough memory for a 41-buffer window into the 120-record (48 gran) disk file. The number of buffers desired will depend on the application program. It is usually best to CLEAR and buffer the maximum amount of available memory.

The initialization routine requests a filename for the plotter image. You are warned if the file already exists. If so, you may clear the file, select a different file, or use the file as a base for overlaying a new design. The overlay option is especially useful for graphing charts. You can generate a grid file by calling the LINE routine an appropriate number of times and then copying it to another file. Thereafter, overlay this file with new data points, lines, or curves. Consider the value of having, for instance, a clean score available for a program that sets notes onto sheet music.

The default filename is PLOT/RAF, which I use for the short-term file. After the design is finished, I save the file by copying with a different filename. My 40-track double-density drives can keep four files on one disk. I leave it to you to write a file-compression program. (Hints: most of the file remains filled with bytes of 80 (hexadecimal), and bytes 242 to 256 of the second sector of every record are unused.)

The routine starting at line 1000 draws a line from point (*x*1,*y*1) to point (*x*2,*y*2). Upon exit, *x*1 and *y*1 have been adjusted to *x*2 and *y*2. Subsequent calls need only redefine *x*2 and *y*2 to simulate a plotter DRAW TO command. This routine is adapted from Mike Higgins' algorithm (see reference 4). It is fast and efficient, requiring only integer variables. This routine determines the points between the two input coordinates and calls line 1500 to set each.

Lines 1500–1590 set the individual dot at the specified coordinates at *x* and *y*. This routine rejects any coordinates that would move the pen outside of the defined limits. It also handles the paging function of the virtual-operating system. Lines 1510 and 1520 constitute the "priming logic." These lines are executed only on the first call to the subroutine. They position the buffered "window" over the correct part of the file. When the Overwrite option is specified during initialization, the indicated records are read in for modification.

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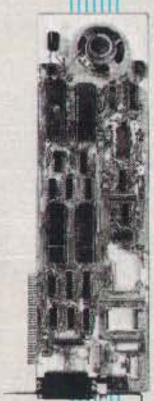

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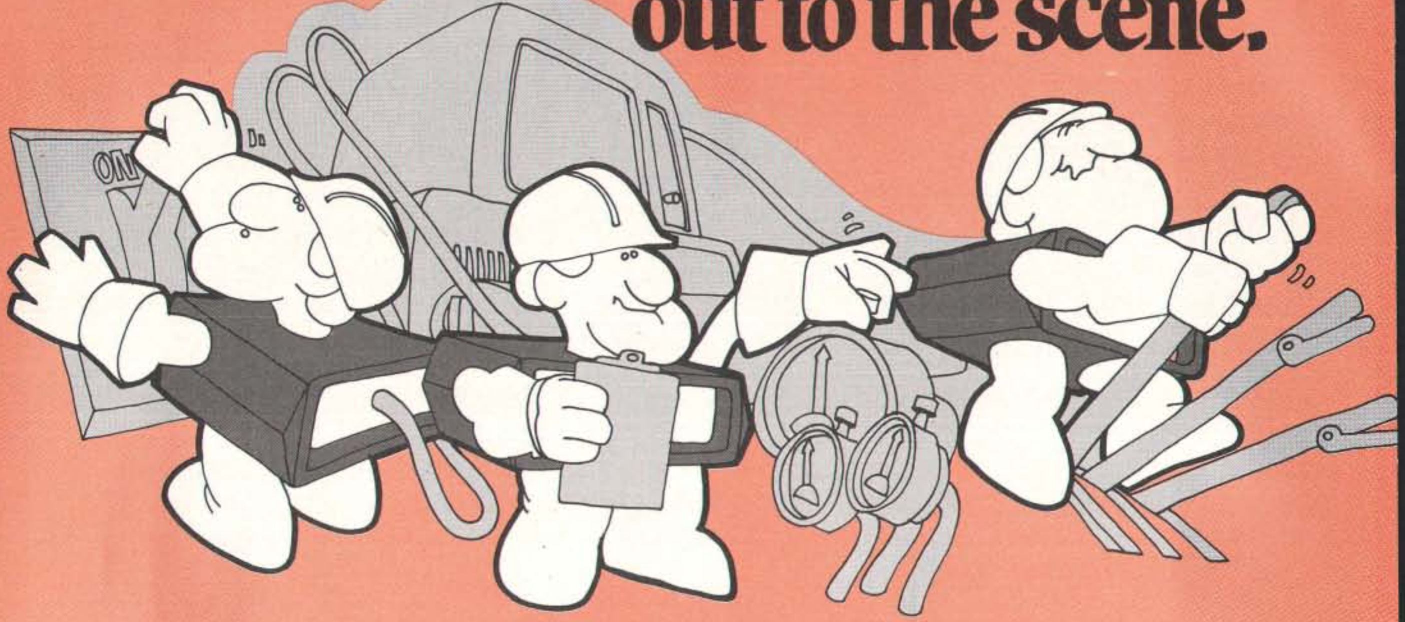

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Listing 2: *The Diskplot plotter/print routines used to print the dragon curves in this article.*

```
950 '**
     **                       DISKPLOT
     **   Virtual memory plotting system for IDS Paper Tigers
     **                  .....by Dan Rollins
960 '**
     ** MUST GOSUB 3000 to open file and initialize variables
     ** MUST GOSUB 4000 to flush buffers and close file
     **
970 '** GOSUB 1000 draws a line from (X1,Y1) to (X2,Y2)
     ** GOSUB 1500 sets a point at (X,Y)
     ** GOSUB 5000 prints the file
     **
980 '** system uses variables L1 to L8
     ** and variables beginning with P (see variables table)
     *****************************************************
990 '**
     ** this routine draws a line from (X1,Y1) to (X2,Y2)
     ** uses L1 - L8, X, Y
     ** leaves X1,Y1 and X,Y pointing to end of line X2,Y2
     **
1000 L1=X2-X1 :L2=Y2-Y1 :L3=0 :L4=1 :L5=1 :L6=0
1010 IF L1<0 THEN L5=-1 :L1=-L1
1020 IF L2<0 THEN L4=-1 :L2=-L2
1030 IF L2>L1 THEN L8=L1 :L1=L2 :L2=L8 :L3=L5 :L5=0 :L6=L4 :L4=0
1040 L7=INT(L1/2) :X=X1 :Y=Y1 :IF L1=0 GOSUB 1500 :RETURN
1050 FOR L8=1 TO L1
1060    GOSUB 1500
1070    X=X+L5 :Y=Y+L6 :L7=L7+L2
1080    IF L7>L1 THEN L7=L7-L1 :X=X+L3 :Y=Y+L4
1090 NEXT :X1=X2 :Y1=Y2 :RETURN
1490 '**
      ** this routine plots 1 dot at (X,Y)
      ** includes virtual memory paging logic
      ** ignores out of range coordinates
      **
1500 IF X<0 OR X>496 OR Y<0 OR Y>P9
       THEN PRINT@ 70,"Coordinate OUT OF RANGE!";CHR$(30);
          :RETURN
1510 IF PZ=0 THEN PZ=1 :CLS :PRINT@ 18,"** plotting **"
       :P1=INT(Y/6)-P8 :IF P1<1 THEN P1=1
          ELSE IF P1>P5 THEN P1=P5-P6 '** priming logic
1520 IF PQ$="O" THEN PQ$="" :GOSUB 2600  '** read for Overlay
1530 P3=INT(Y/6) :P4=Y-P3*6 :P3=P3+1 :P7=P3-P1+1
1540 IF P7=P6+1 THEN GOSUB 2000
       ELSE IF P7=0 THEN GOSUB 2100
         ELSE IF P7<0 OR P7>P6+1 THEN GOSUB 2200
1550 PH=0 :PL=X+1 :IF PL>255 THEN PH=1 :PL=PL-255
1560 PP=ASC(MID$(PB$(P7,PH),PL,1)) OR PD(P4)
1570 MID$(PB$(P7,PH),PL,1)=CHR$(PP) :PW(P7,PH)=1 '** set flag
1580 PRINT@ 70,USING PU$;X,Y,P3,P7,P4;
1590 RETURN
1990 '**
      ** Y is too large so move window DOWN with overlap
      **
2000 FOR P7=1 TO P8 :P3=P1+P7-1 :GOSUB 2800 :NEXT
2010 FOR P7=1 TO P8-1
2020    MID$(PB$(P7,0),1)=PB$(P8+P7,0) :PW(P7,0)=PW(P8+P7,0)
2030    MID$(PB$(P7,1),1)=PB$(P8+P7,1) :PW(P7,1)=PW(P8+P7,1)
2040 NEXT :P1=P1+P8
2050 FOR P7=P8 TO P6 :P3=P1+P7-1 :GOSUB 2700 :NEXT
2060 P7=P8 :RETURN
2090 '**
      ** Y is too small so move window UP with overlap
      **
2100 FOR P7=P8 TO P6 :P3=P1+P7-1 :GOSUB 2800 :NEXT
2110 FOR P7=P8+1 TO P6
2120    MID$(PB$(P7,0),1)=PB$(P7-P8,0) :PW(P7,0)=PW(P7-P8,0)
2130    MID$(PB$(P7,1),1)=PB$(P7-P8,1) :PW(P7,1)=PW(P7-P8,1)
2140 NEXT :P1=P1-P8
2150 FOR P7=1 TO P8 :P3=P1+P7-1 :GOSUB 2700 :NEXT
2160 P7=P8 :RETURN
2190 '**
      ** move window to another part of the page (no overlap)
      **
2200 PQ=P3 :GOSUB 2500           '** write all buffers
2210 P1=PQ-P8+1 :GOSUB 2600      '** read all buffers
2220 P7=P8 :P3=PQ :RETURN
2490 '**
      ** write all buffers to appropriate records
      **
2500 FOR P7=1 TO P6 :P3=P1+P7-1 :GOSUB 2800 :NEXT
2510 RETURN
2590 '**
      ** read all buffers from disk
      **
2600 FOR P7=1 TO P6 :P3=P1+P7-1 :GOSUB 2700 :NEXT
2610 RETURN
2690 '**
      ** read record P3 into buffer P7
      **
2700 IF P3<1 OR P3>P5 THEN RETURN '** no such logical record
2710 P2=P3*2-1'                   '** calculate physical record
2720 PRINT@ 132,USING"READING Buffer ## from Record ###";P7,P3;
2730 GET 1,P2 :MID$(PB$(P7,0),1)=PR$ :PW(P7,0)=0 '** reset flag
2740 GET 1,P2+1 :MID$(PB$(P7,1),1)=PR$ :PW(P7,1)=0
2750 PRINT@ 132,CHR$(30);
2760 RETURN
2790 '**
      ** write buffer P7 to record P3
      **
2800 IF P3<1 OR P3>P5 THEN RETURN
2810 P2=P3*2-1
2820 PRINT@ 132,USING"WRITING Buffer ## to Record ###";P7,P3;
2830 IF PW(P7,0) THEN LSET PR$=PB$(P7,0) :PUT 1,P2
2840 IF PW(P7,1) THEN LSET PR$=PB$(P7,1) :PUT 1,P2+1
2850 PRINT@ 132,CHR$(30);
2860 RETURN
```

Listing 2 continued on page 476

Listing 2 continued:

```
2990 '**
     ** Initialize file and virtual plotting system variables
     ** MUST call here FIRST, having CLEARed string space
     **
3000 CLS :PRINT@ 71,"Virtual Memory Plotter Emulator"
3010 DEFINT P,L :PRINT :PRINT
3020 X=0 :Y=0 :P3=0 :P1=0 :P7=0 :PH=0 :PL=0 :PP=0'** used often
3030 P6=31
     :INPUT "Number of memory buffers (3-41, default=31)";P6
3040 P6=P6 OR 1 :P8=INT(P6/2)+1 :IF P6<3 OR P6>41 GOTO 3030
3050 DIM PB$(P6,1), PW(P6,1) '** buffers, write flags
3060 P9=720
     :INPUT"Vertical Page length in dots (default=720)";P9
3070 P5=INT(P9/6+.9) :PC$=STRING$(255,128) :PRINT
3080 PF$="PLOT/RAF"
     :INPUT "plotter-image filespec (default='PLOT/RAF')";PF$
3090 OPEN "R",1,PF$ :FIELD 1,255 AS PR$
3100 IF LOF(1)=0 THEN PS=1 :GOTO 3170
3110 PRINT"file: ";PF$" already exists!!!"
3120 INPUT"(C) Clear,(O) Overlay or (D) use Different file";PQ$
3130 IF PQ$="C"
     THEN PRINT"Are you sure you want to clear ";PF$;" (Y/N)";
     :INPUT PQ$ :IF PQ$="Y" THEN CLOSE 1 :KILL PF$ :GOTO 3090
                ELSE 3120
3140 IF PQ$="D" THEN CLOSE 1 :GOTO 3080
3150 IF PQ$<>"O" GOTO 3120
3160 IF LOF(1)<P5*2 THEN PS=LOF(1) ELSE 3220
3170 CLS :LSET PR$=PC$
3180 FOR PQ=PS TO P5*2
3190    PRINT@ 0,USING"Initializing file sector ###";PQ
3200    PUT 1,PQ
3210 NEXT
3220 FOR PQ=1 TO P6 :PB$(PQ,0)=PC$ :PB$(PQ,1)=PC$ :NEXT
3230 PU$="X=### Y=### Record=### Buffer=### Bit=#"
3240 PD(0)=1 :PD(1)=2 :PD(2)=4 :PD(3)=8 :PD(4)=16 :PD(5)=32
3250 CLS :PZ=0 :RETURN
3990 '**
     ** flush buffers and close file
     ** MUST call here LAST
     **
4000 CLS :PRINT"Closing file:  ";PF$
4010 GOSUB 2500 :CLOSE 1
4020 PRINT"file closed" :PRINT
4030 INPUT"press <ENTER> to continue"; PQ$
4040 RETURN
4990 '**
     ** routine prints entire file to Paper Tiger
     **
5000 CLS :PRINT"Print graphics file to Paper Tiger"
5010 PRINT :PRINT :PRINT"Ready Printer" :PRINT
5020 PRINT"input filespec (default = '";PF$;"'  )";
5030 INPUT PF$ :IF LEN(PF$)=0 GOTO 5020
5040 OPEN"R",1,PF$ :FIELD 1,255 AS PR$
5050 IF LOF(1)=0 THEN PRINT"NO SUCH FILE!"
       :CLOSE 1 :KILL PF$ :GOTO 5020
5060 PE$=CHR$(131)
5070 LPRINT : LPRINT CHR$(158);PE$;             '** 12 CPI graphics
5080 LPRINT PE$;CHR$(139);                      '** line feed
5090 FOR P2=1 TO LOF(1) STEP 2
5100    GET 1,P2 :PL=255 :GOSUB 5200
5110    GET 1,P2+1 :PL=242 :GOSUB 5200
5120    LPRINT PE$;CHR$(139);                   '** line feed
5130    IF INKEY$=CHR$(31) THEN P2=LOF(1) '** <CLEAR> to abort
5140 NEXT :LPRINT PE$;CHR$(130);            '** enter normal mode
5150 LPRINT :CLOSE 1
5160 RETURN
5190 '**
     ** prints first PL characters from PR$
     ** contains logic for embedded graphics ESC
     **
5200 PJ=1
5210 PQ=INSTR(PJ,PR$,PE$)
5220 IF PQ=0 THEN LPRINT MID$(PR$,PJ,PL-PJ+1); :RETURN
5230 LPRINT MID$(PR$,PJ,PQ-PJ);PE$;PE$;
5240 PJ=PQ+1 :IF PJ<=PL THEN 5210 ELSE RETURN
```

```
10000 '*********************************************************
       **                Variables Usage Table                  **
       **  name                  function                       **
10010 '**                                                       **
       ** P1     RECORD in BUFFER 1 (lowest in memory)          **
10020 '** P2     physical file sector (used in GET and PUT)     **
10030 '** P3     current RECORD (Y/6)                           **
10040 '** P4     current bit to set (Y mod 6)                   **
10050 '** P5     highest RECORD on disk (P9/6)                  **
10060 '** P6     total number of BUFFERS (is forced odd)        **
10070 '** P7     BUFFER currently being accessed                **
10080 '** P8     middle BUFFER (INT(P6/2)+1)                    **
10090 '** P9     total vertical dots  (maximum Y)               **
10100 '**                                                       **
10110 '** PH     high or low string of BUFFER (1 or 0)          **
10120 '** PL     X offset within BUFFER string (1-255)          **
       **           also length of string to LPRINT             **
10130 '** PP     current value of byte to alter                 **
10140 '** PQ     temporary value, counter                       **
10150 '** PJ     temporary value, counter                       **
10160 '** PS     sector to start clearing file                  **
10170 '** PZ     priming variable (=1 on first call to 1500)    **
10180 '** X      horizontal ordinate to plot                    **
10190 '** Y      vertical ordinate to plot                      **
10200 '** X1,Y1  starting point of line to draw                 **
10210 '** X2,Y2  ending point of line to draw                   **
10220 '**                                                       **
10230 '** PD(n)  value to OR for setting dot n (0 is top)       **
10240 '** PW(n,1) flag indicates that a BUFFER is updated       **
10250 '**                                                       **
```

Listing 2 continued on page 478

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Listing 2 continued:

```
10260 '** PB$(n,1) BUFFER storage strings (255 char. length) **
10270 '** PC$      255 graphical blanks ( CHR$(128) )        **
10280 '** PE$      graphics escape CHR$(131)                 **
10290 '** PF$      disk filename for plotter image           **
10300 '** PQ$      priming flag (="0" for Overlay option)    **
10310 '** PR$      FIELDed string (funnels all disk data)    **
10320 '** PU$      PRINT USING image for plotting data       **
10330 '**                                                    **
10340 '** L1       Distance of long-axis                     **
10350 '** L2       Distance of short-axis                    **
10360 '** L3,4,5,6 horizontal and vertical steps (1,-1,or 0) **
10370 '** L7       duty master (for determining ratio)       **
10380 '** L8       temporary value, long-axis counter        **
10390 '**                                                    **
       ********************************************************
```

If, upon entry, the specified *x* ordinate is out of range of the window buffers, line 1540 calls the subroutine for the required action, i.e., moving the window up or down with overlap or placing the window at an entirely different part of the file.

Line 1570 makes the actual modification to the indicated buffer, turning on the dot at the *x,y* coordinate. The correct buffer is selected, then an OR is performed on the current value of the *x*th byte of the buffer with a value that will fire the correct printhead pin upon output. Then, using the "MID$ =" assignment function, this combined value is placed back into the buffer. A flag is then set, indicating that the selected buffer has been altered.

Just as the initialization routine must be called before any plotting takes place, the CLOSE routine at line 4000 must be called when the design is finished. All the altered buffers at the ending window position are flushed out to the disk, and the file is properly closed.

Lines 5000 to 5240 constitute a stand-alone routine for printing a graphics file. An input prompts for a filename, indicating a default string of the last-used filename. The printer is set to 12 cpi (characters-per-inch) in graphics mode and the 2K-byte buffer is emptied. Then the file is read and two disk sectors are printed per physical printer line. The routine at 5200 does a scan of the print line to check for an ETX control character embedded in the file. When none exists, the entire line is printed unchanged. Otherwise the string is printed up to the ETX, an ETX is printed twice, and the line is scanned again until the entire string has been output.

The top three lines of the video are reserved for Diskplot data display. The system keeps you informed of what's happening at all times. Every call to Diskplot prints the current *x* and *y*, the currently accessed buffer and record, and the bit being set in the current byte. Every time the disk is accessed, the buffer and record numbers are displayed. While displaying this data slows execution, it is a handy debugging device and lets you know that everything is running smoothly.

The final lines of listing 2 document the variables used by the Diskplot program. Notice that each variable in the dot-plotting routine begins with the letter P. All variables in the line-drawing routine begin with L. This makes it easier to interface the routines with a variety of application programs. Loops are indented and remarks indicate the logical subroutines and their functions.

The program may be speeded up by eliminating spaces and remarks and combining lines where feasible. You might also consider placing the often-called routines early in the program. All the variables are defined as integers and those most often used have been defined early to shorten the amount of time BASIC needs to look them up. Most of the duration of each call to Diskplot is in the calculations to determine the buffer number and the position within the buffer to be altered. So even though the routines are disk-intensive, specifying a large number of buffers usually ensures that the program is not "I/O bound."

When no paging action is required, each dot takes about 0.24 seconds to plot. The duration of each call can be lowered to about 0.17 seconds by removing the PRINT USING command at line 1580. The order-12 example dragons each call the SET routine over 25,000 times. These designs take about 90 minutes for the plotting and printing phases. Because Diskplot uses standard BASIC commands, the routines could be compiled for a substantial time savings.

Summary

Just as the classical dragon curve is a special case of the generalized dragon curve, the generalized dragon curve might be considered the two-dimensional aspect of an even broader class of three-dimensional curves. Some interesting possibilities present themselves when the folds of the curve are at angles of other than 90 degrees.

The virtual-memory algorithms I've described work well with the dragon-curve program, but they can be inefficient in other applications. The line-drawing module could be improved by doing some preliminary paging, preparing the window in advance.

The Diskplot package has become a valuable addition to my subroutine library. The dragon curves that could only be drawn with this package make an impressive display.■

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3. Gardner, Martin. "Mathematical Games," *Scientific American*, March 1967, page 124 and April 1967, page 118.
4. Higgins, Mike. "Fast Line-Drawing Technique," August 1981 BYTE, page 414.

Dan Rollins (134 Olive St., Glendale, CA 91206) is a freelance programmer and technical writer. He is currently writing a book entitled IBM-PC 8088 Macro Assembler Programming, *soon to be published by Macmillan.*

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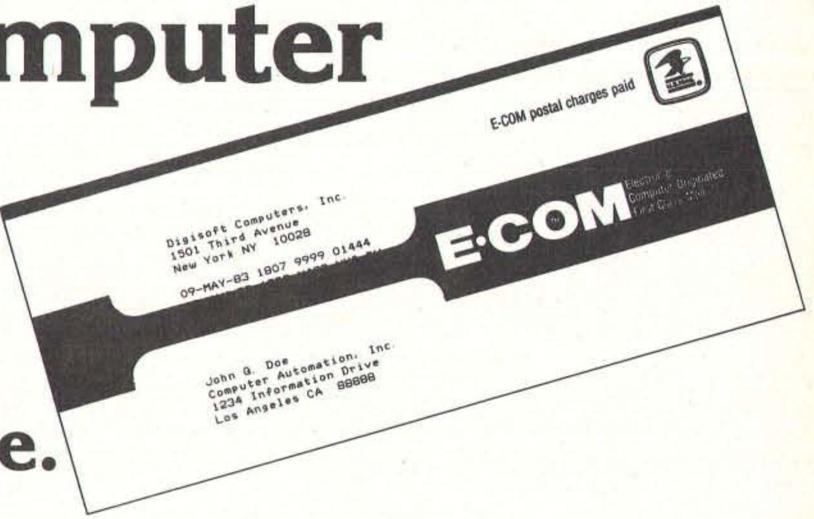

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by Stuart Edwards

Quick! What's the volume of the Earth in teaspoons? If you said 2.1931217 × 10^{26} teaspoons, you're right (assuming Earth is a sphere with a 3956-mile radius).

It's more likely, though, that you couldn't conveniently calculate that figure even with a microcomputer or calculator. Indeed, you would probably find any practical calculations involving extensive conversions of units similarly tedious.

To perform such calculations as those involved in determining the volume of the Earth in teaspoons, I use a system that employs a microcomputer and is based on the muSIMP/ muMATH package (from The Soft Warehouse). I call my configuration a super-calculator because it performs standard calculator functions (addition, subtraction, multiplication, division, and so on) and also carries units along algebraically in the calculation and expresses results in whatever units I want. I can pose a problem for the calculator giving at once all relevant information, including measured data values, the units in which the measurements are taken, the form of the mathematical expression to be used in the calculation, and the units in which the result is to be expressed. The system then takes care of all details, including applying appropriate conversion factors and, more important, checking algebraically that the required units make sense in terms of the formula used and the units in which the quantities are entered.

The text box on page 484 shows input statements and answers for three sample problems.

How the Super-Calculator Works

Any computer algebra system, including the one I use, can work with undefined terms; that is, addition, subtraction, multiplication, division, and even exponentiation can be performed using variables that have no assigned numerical values. Consider, for example, the following super-calculator input and output statements:

```
? 3 (X + 2 X^2) Y;
@: 3 X Y + 6 X^2 Y
```

The ? in the first line is a prompt. The rest of the line is the question "What is $3(X+2X^2)Y$?," terminated by a semicolon. The second line contains the result ($3XY+6X^2Y$) determined by the system after applying the normal rules of algebra (in this case, distribution of the 3 and the Y over the sum within the parentheses); the @: combination signifies "the answer is."

Together, the two lines (one input and one output) constitute what I call a transaction—an element of interaction with the computer. This interaction consists of posing an algebraic problem and receiving the evaluated result. The time required for the system to respond depends on the complexity of the problem posed and on the speed of the computer. For simple transactions such as most of the ones presented in this article, a 3- or 4-second response for a Z80 running at 4 MHz is typical.

After completion of a transaction, the @ may be used to represent that transaction's result in a subsequent transaction. Thus, after completion of the above transaction, the next transaction might appear as follows:

```
? @ / X;
@: 3 Y + 6 X Y
```

Here, @ / X means "the previous result divided by X"; @ represents the result of the last transaction, the X factor is divided into each term, and the new answer (or new @) is 3Y + 6XY.

Although it is not necessary to assign numerical values to variables, such assignments can certainly be made, as the next four lines (two transactions) illustrate:

```
? X: 3;
@: 3
? 5 X^ 2;
@: 45
```

The first transaction assigns the value 3 to X, and the second transaction shows the result of a numerical calculation with this new value substituted for X.

We may also assign non-numeric "values" to variables; values may be other undefined variables or even expressions involving undefined variables:

```
? X: THIS EXPRESSION;
@: THIS EXPRESSION
? (5 X)^ 2;
@: 25 THIS^ 2 EXPRESSION^ 2
```

Here, the first transaction assigns the expression THIS EXPRESSION to X. (This expression must be read as THIS times EXPRESSION, because whenever two factors appear side by side with no intervening operator, multiplication is assumed, as in standard algebra.) The second transaction shows how the new value of X is substituted into an expression, followed by the distribution of the exponent 2 over the individual factors 5, THIS, and EXPRESSION. Because 5 is a number, 5^2 may be immediately evaluated as 25; the other factors, being undefined, cannot be squared and thus are left as THIS^2 and EXPRESSION^ 2.

This capability to assign to variables values that are expressions in terms of other variables is the key to the super-calculator. In my super-calculator configuration, for example, I allow the variable "second" to be an undefined unit of time, but a "minute" is defined in terms of the "second," as:

```
? minute: 60 second;
@: 60 second
```

An "hour" may be defined in terms of the second:

```
? hour: 3600 second;
@: 3600 second
```

or, because we have already defined minute:

```
? hour: 60 minute;
@: 3600 second
```

The system has substituted the value of minute into the expression. The value of hour is now 3600 second, not 60 minute: when I make an assignment, it is the evaluated result ("3600 second") that is assigned, not the "raw" input expression ("60 minute").

Now when I use the word "minute" in my calculations, it is interpreted as "60 second," and "hour" is interpreted as "3600 second." Here are some other units of time:

```
? day: 24 hour;
@: 86400 second
? week: 7 day;
@: 604800 second
? year: 365.2422 day;
@: 3.1556926 10^7 second
? decade: 10 year;
@: 3.1556926 10^8 second
? century: 100 year;
@: 3.1556926 10^9 second
```

In each case, the assigned value is the evaluated result in seconds, which is now my default standard unit of time. (Note that the numerical part of each answer, if it is very large, is expressed in scientific notation; this is what a regular scientific calculator would do. The same is true in the case of very small numbers.)

Similar considerations apply to units of length. I choose a standard unit in terms of which all lengths are defined, leaving this default standard unit as an undefined variable. If the standard is the meter, I enter the units of length as follows:

```
? centimeter: 1/100 meter;
@: 0.01 meter
? millimeter: 1/1000 meter;
@: 0.001 meter
? micrometer: 10 ^ -6 meter;
@: 10^ -6 meter
? nanometer: 10 ^ -9 meter;
@: 10 ^ -9 meter
? kilometer: 1000 meter;
@: 1000 meter
? inch: 2.54 centimeter;
@: 0.0254 meter
? foot: 12 inch;
@: 0.3048 meter
? yard: 3 foot;
@: 0.9144 meter
? mile: 5280 foot;
@: 1609.344 meter
```

Areas are handled as squared units of length because the usual rules of algebra apply. That is, when I multiply two lengths, I expect the result to be an area:

```
? (5 foot) (3 meter);
@: 4.572 meter ^ 2
```

To be consistent with the units of length, I use the square meter as my standard default unit of area. I also add a few more areas:

```
? are: 100 meter ^2;
@: 100 meter ^ 2;
? hectare: 100 are;
@: 10000 meter^ 2
? acre: 1/640 mile ^2;
@: 4046.8564224 meter ^ 2
```

Similarly, volumes are by default expressed in cubic meters. Some extra units of volume are:

```
? USgallon: 3785.32 centimeter ^3;
@: 0.0037853 meter ^ 3
? IMPgallon: 4545.96 centimeter ^3;
@: 0.0045459 meter^ 3
? quart: 1/4 USgallon;
@: 9.4633 10^ -4 meter ^ 3
? pint: 1/2 quart;
@: 4.73165 10 ^ -4 meter ^ 3
? cup: 1/2 pint;
@: 2.365825 10 ^ -4 meter^ 3
? fluidounce: 1/2 cup;
@: 2.9572812 10 ^ -5 meter ^ 3
? tablespoon: 1/2 fluidounce;
@: 1.4786406 10 ^ -5 meter ^ 3
? teaspoon: 1/3 tablespoon;
@: 4.9288020 10 ^ -6 meter ^ 3
```

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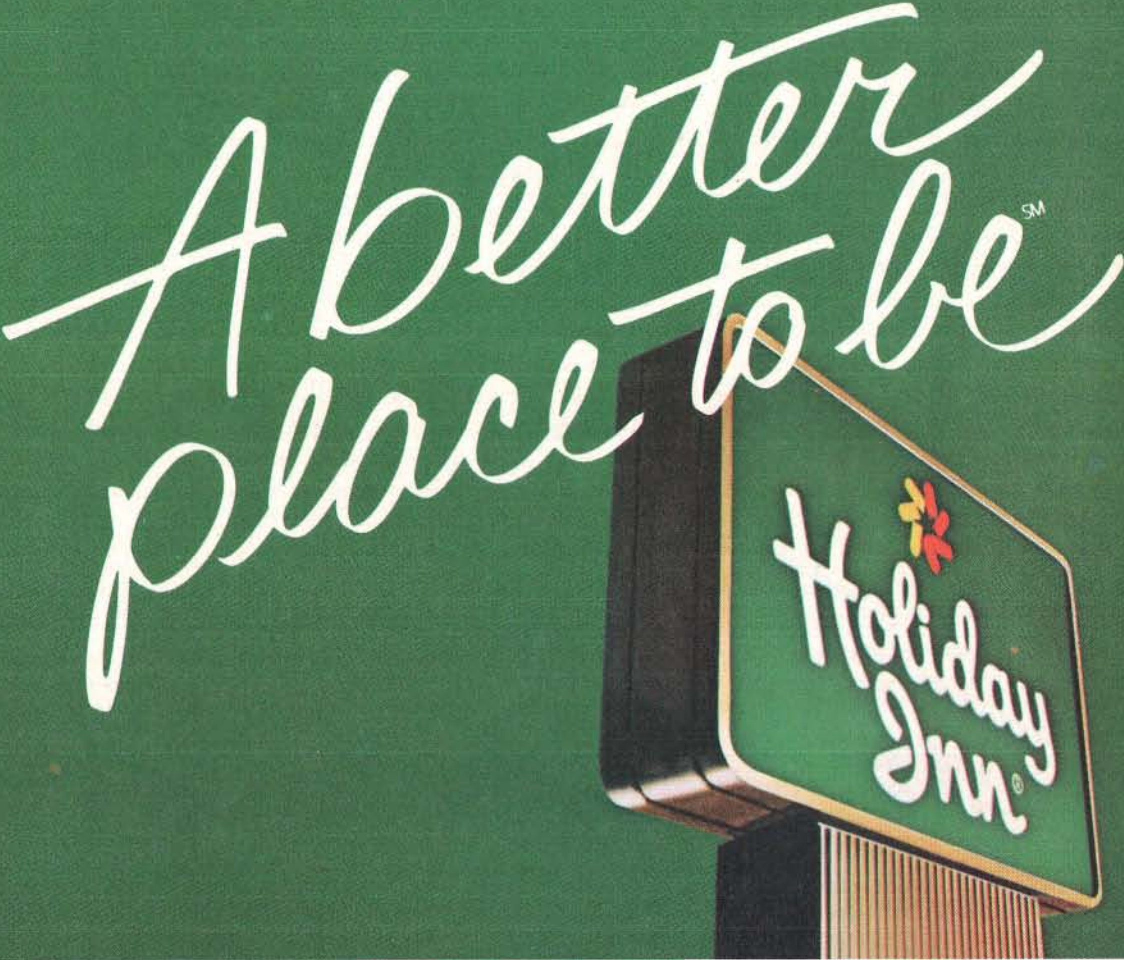

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The Super-Calculator in Action

The following sample problems and solutions illustrate operation of the super-calculator system.

Assuming the Earth is a sphere with a radius of 3956 miles, what is its volume in teaspoons?

Solution:

```
? 4 pi / 3 (3956 mile)^3 in teaspoon;
@: 2.1931217 10 ^26 teaspoon
```

If you purchase 5 liters of gasoline and use it to drive 53 kilometers, what is your mileage in miles per gallon?

Solution:

```
? 53 kilometer / (5 liter) in mile / gallon;
@: 24.9321412 mile / gallon
```

According to Einstein's mass-energy relation, $E=mc^2$. What energy is released, in kilowatt years, by the complete conversion of 1 kilogram of mass?

Solution:

```
? 1 kg c ^2 in kilo watt year;
@: 2848035.4213258 kilo watt year
```

Derived Units

By now I have an array of units and derived units that is quite extensive. By "derived units" I mean things like units of velocity (such as inches per second or kilometers per hour) or units of acceleration (such as feet per second squared). For instance, consider the number of ways to enter velocities. A velocity is nothing more than a distance divided by a time interval; because I have introduced 9 units of length and 8 units of time, there are 9×8, or 72, derived units of velocity at my disposal. These include ordinary things like miles per hour:

```
? 55 mile / hour;
@: 24.5872 meter / second
```

and exotic things like yards per week:

```
? 1001 yard / week;
@: 0.0015134 meter / second
```

Any expression with a unit of length in the numerator and a unit of time in the denominator is an acceptable velocity and is converted automatically to meters per second.

I avoid plural forms such as "miles" or "seconds." Using only singular forms, I can enter new units without having to enter their plural forms. This method is a personal preference; other users may be happier defining all possible forms of a unit (i.e., pound, pounds, lb, lbs) so the terms can be used interchangeably.

Each time I add a new unit of length or time, my inventory of derived units expands; the size of the expansion depends on how many other units are already assigned. To get a sense of how far this concept can be taken, consider that I have available in my system 9 units of time (from seconds to centuries) and 17 units of length (from angstroms to parsecs); thus, there are 9×17, or 153, ways of entering velocities. And there is nothing to prevent the addition of even more units of time or length.

Many derived units are formed by combining lengths and times, as in the case of units of acceleration. Again, any valid expression with one length unit in the numerator and the product of two time units in the denominator is a valid acceleration. This is the salient feature of the super-calculator: as long as the units make sense in terms of the quantity being entered, the expression is accepted and automatically converted to standard units.

Unit Prefixes

To add to the repertoire of times and distances, I introduced prefixes. I had initially intended to put in such things as microseconds, nanometers, and kilometers, but that would have been cumbersome. I decided instead to make the prefixes separate quantities to which I assigned appropriate numerical values (1000 for "kilo," 1/1000000 for "micro," and so on. Now, to express a time in microseconds, I have:

```
? 1.23 micro second;
@: 1.23 10 ^ -6 second
```

The prefix "micro" has been split from the root "second," and the implicit multiplication takes care of the conversion. The advantage of this method is that the prefixes are now available for all units in the system; I can work in nanoyards ("nano yard"), megaweeks ("mega week"), or any other such units. All 14 standard unit prefixes, from atto (10^{-18}) to tera (10^{12}), are entered, which yields a variety of length and time units and derived units for velocities or accelerations.

The "in" Operator

After defining all these units, I can enter expressions in whatever units are appropriate for the problem at hand. The manner in which the units are defined assures that times are converted to seconds, distances to meters, areas to square meters, volumes to cubic meters, and so forth. This is fine if I am content to have all results displayed in these units and want to perform complex calculations in a standard set of units such as the S.I. system or the centimeter-gram-second system.

Requiring such a standard puts us in a straitjacket—in the real world, not everything is standardized, and a calculator, to be useful, should be capable of expressing its results in the units I want.

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The "in" operator was created for flexibility. The "in" operator is an infix operator: a function named "in" receives one argument each on the left and on the right, much as do the arithmetic operators +, −, /. The argument on the left is the expression to be evaluated, and the one on the right is the set of units in which the result is to be expressed:

```
? 55 mile / hour in foot / second;
@: 80.6666666 foot / second
```

The "operator precedence" of "in" is lower than that of the arithmetic operators; in the example, "55 mile / hour" is the left argument, "foot / second" is the right argument.

The "in" operator does four things:

1. It evaluates the expression on the left, getting a result in standard units. "55 mile / hour" becomes "24.5872 meter / second" because meter and second are my standard units of length and time. This result is not displayed but is held internally in a temporary work area.
2. It evaluates the expression on the right, the required set of units, again obtaining its standard equivalent. "foot / second" becomes "0.3048 meter / second."
3. It algebraically divides the result from step 1 by the result from step 2. The common factors, meter and second, cancel out of the numerator and the denominator, leaving the dimensionless quantity 80.6666666 (i.e., 24.5872 / 0.3048).
4. It constructs a new expression consisting of the numeric result from step 3 multiplied by the unevaluated right argument, which gives "80.6666666 foot / second," the displayed result.

The definition of "in" is very general, enabling the use of complex expressions on the left and the right; physical constants can be used as units, as when I use "g":

```
? g: 32.174 foot / second ^ 2;
@: 9.8066352 meter / second ^2
```

to represent the standard acceleration due to gravity, as in the following transaction, which I'll call A:

```
? g 1/2 (5.32 second) ^ 2 in yard;
@: 151.7669029 yard
```

or as a unit of acceleration in the transaction that I'll call B:

```
? 60 mile / hour / (7 second) in g;
@: 0.3907325 g
```

In transaction A, I use g as a physical constant to compute the distance in yards an object would fall in 5.32 seconds (ignoring air resistance). In transaction B, I use this same g as a unit of acceleration, expressing the average acceleration of an automobile going from 0 to 60 miles per hour in 7 seconds.

The "in" operator never produces an algebraically incorrect result.

The "in" operator also protects against getting the wrong dimensions. Because the division in step 3 is done algebraically, the units would not cancel unless they are the same in the numerator and the denominator. In other words, the dimensions of the required units must be the same as those of the result. If this is not true—for example, if the required units are feet, but the expression yields a time interval in seconds—the units would not cancel out, and unexpected units would be introduced to force an algebraically correct answer. For example,

```
? 2500 mile / (450 mile / hour) in foot;
@: (65616.7979002 second / meter) foot
```

By introducing the extra "meter" in the denominator, the system is indicating there is a mismatch in dimensions. The answer returned in this case is a time, not a length, which is apparent because the result is not in the units requested.

By similar reasoning, if the result does appear in the required units, I can be reasonably sure the dimensions are being correctly manipulated. This does not always prevent me from using the wrong formula; however, it does provide an excellent check, especially when the algebra becomes too complex for the dimensions to be known intuitively. Something is wrong if I expect an acceleration for an answer but get a frequency instead; these algebraic techniques enable me to detect such errors immediately, regardless of the complexity of the computation.

If I realize I've made an error and want that result expressed in hours,

```
? @ in hour;
@: 5.5555555 hour
```

puts the expression right. The "in" operator never produces an algebraically incorrect result; even if I get the dimensions wrong, I can still recover easily, now that I know the result is a time and not a length.

Other Dimensions

Units of time and length are only the beginning. I also need mass (standard unit "gram"), electric charge ("coulomb"), magnetic flux ("weber"), and money ("USdollar"). For each dimension, I can add other nonstandard units. Mass can be expressed in pounds, slugs, tons, atomic mass units, carats, and ounces; electric charge can be expressed in units of the charge on an electron; magnetic flux can be expressed in maxwells; money can be expressed in cents, megabucks, or in other currencies such as yen or pounds sterling (provided I keep the exchange rates current).

Derived units can include a variety of energies (ergs, Btus, joules, kilowatt-hours, electron volts, horsepower-hours, foot-pounds); pressures (atmospheres, millimeters of mercury, pounds per square inch); forces (dynes, newtons); and so on. The total amount of memory available in the computer is the limiting factor; each new definition uses as much as 40 or 50 bytes of storage, depending on the length of its name

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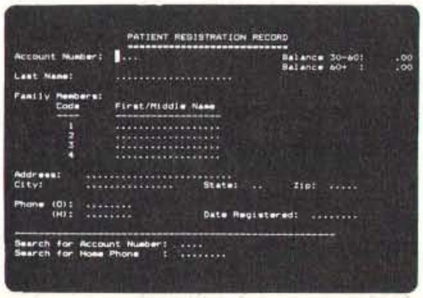
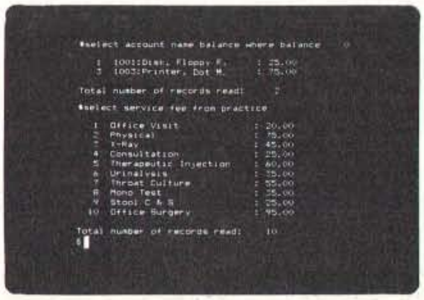


```
                    PATIENT REGISTRATION RECORD
                    ===========================
Account Number: ....                          Balance 30-60:     .00
                                              Balance 60+  :     .00
Last Name:      ....................

Family Members:
        Code      First/Middle Name
        ----      -----------------
         1        .................
         2        .................
         3        .................
         4        .................

Address:      .........................
City:         ...............      State: ..    Zip: .....

Phone (O):    ........
      (H):    ........             Date Registered:  ........
---------------------------------------------------------
Search for Account Number: ....
Search for Home Phone    : ........
```



```
*select account name balance where balance   0

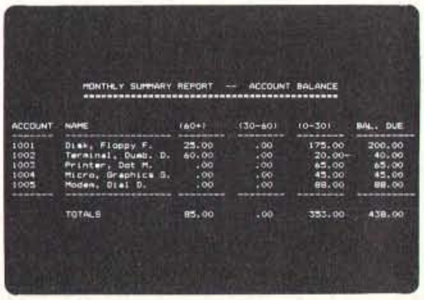
   1  1001:Disk, Floppy F.      : 25.00
   3  1003:Printer, Dot M.      : 75.00

Total number of records read:     2

*select service fee from practice

   1  Office Visit               : 20.00
   2  Physical                   : 75.00
   3  X-Ray                      : 45.00
   4  Consultation               : 25.00
   5  Therapeutic Injection      : 60.00
   6  Urinalysis                 : 35.00
   7  Throat Culture             : 55.00
   8  Mono Test                  : 35.00
   9  Stool C & S                : 25.00
  10  Office Surgery             : 95.00

Total number of records read:    10
$
```



```
           MONTHLY SUMMARY REPORT  --  ACCOUNT BALANCE
           ===========================================

ACCOUNT  NAME                (60+)     (30-60)    (0-30)     BAL. DUE
-------  ------------------ --------- ---------- ---------- ----------
1001     Disk, Floppy F.     25.00       .00       175.00     200.00
1002     Terminal, Dumb. D.  60.00       .00        20.00-     40.00
1003     Printer, Dot M.       .00       .00        65.00      65.00
1004     Micro, Graphics S.    .00       .00        45.00      45.00
1005     Modem, Dial D.        .00       .00        88.00      88.00
-------  ------------------ --------- ---------- ---------- ----------

         TOTALS              85.00       .00       353.00     438.00
```

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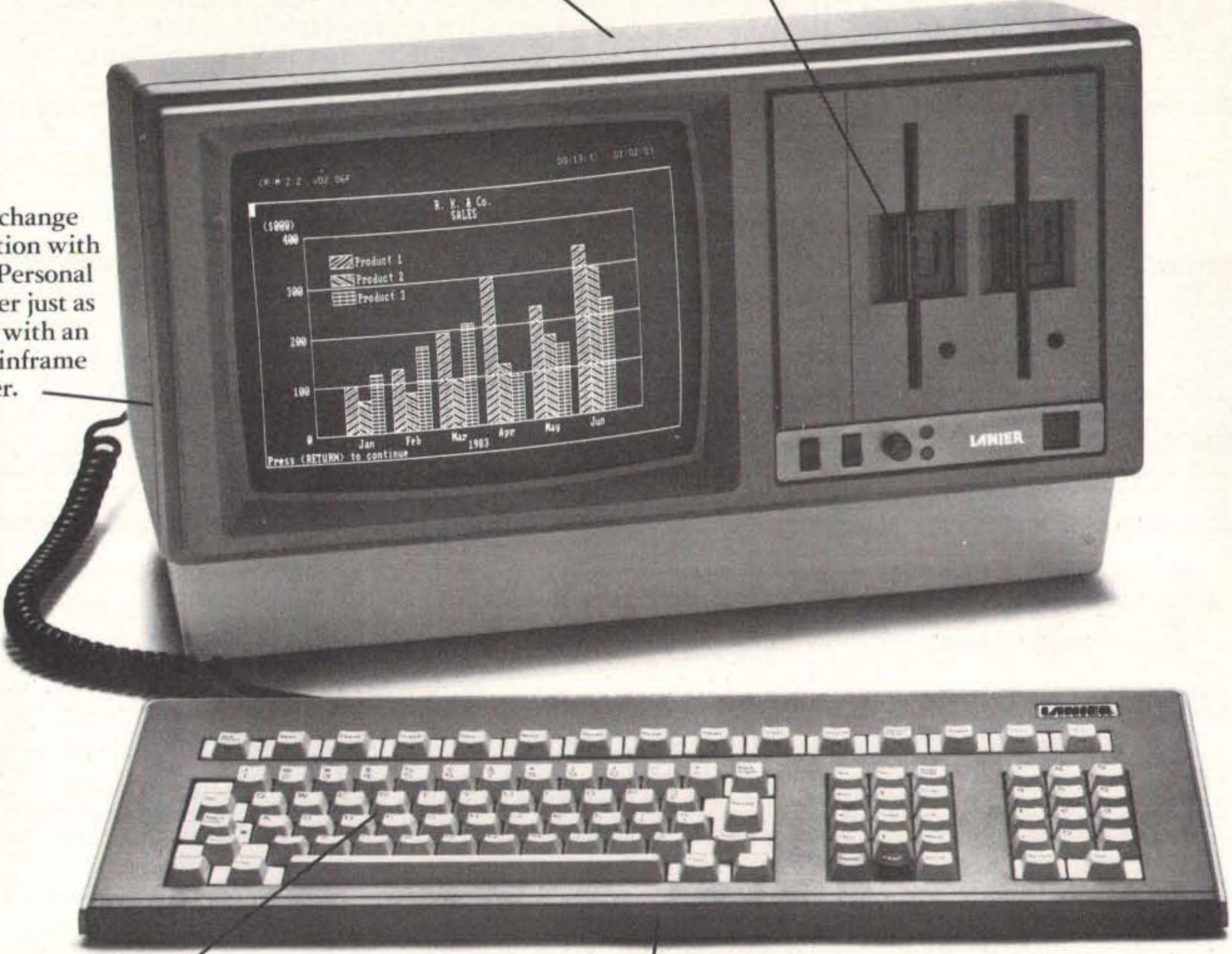

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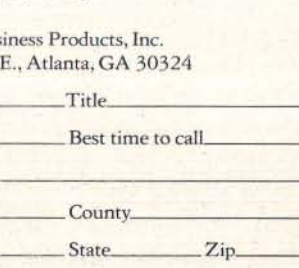

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and the complexity of the expression describing it. For example, the unit

```
? newton: kilo gram meter / second^2;
@: 1000 gram meter / second^2
```

takes 44 bytes to store.

To clarify the descriptions in this article, I have spelled out all units. In a practical system, abbreviations would be handy:

```
? kg: kilo gram;
@: 1000 gram
```

or

```
? ft: foot;
@: 0.3048 meter
```

Abbreviations can easily be defined, subject to the storage limitation. Synonyms can also be used:

```
? gallon: USgallon;
@: 0.0037853 meter^3
? kilogram: kilo gram;
@: 1000 gram
```

Function Definitions

For formulas I want to use repeatedly, I can define functions, as in a programming language. For example, the expression representing the gravitational force acting between two masses, m_1 and m_2, separated by a distance d, and acted upon by the universal gravitational constant G, is:

$$Gm_1m_2/d^2$$

To use this formula, I first need the constant G:

```
? G: 6.6732 10^-11 meter^3 /
    kilogram / second^2;
@: 6.6732 10^-14 meter^3 /
    (gram second^2)
```

and then a function definition:

```
? gravity (m1, m2, d): G m1 m2 /
  d^2;
@: gravity
```

The function "gravity" has three parameters—m1, m2, and d—that are replaced by corresponding argument values when the function is invoked. For instance,

```
? gravity (5.3 kilogram, 20 pound,
    5 meter) in newton;
@: 1.2834098 10^-10 newton
```

expresses in newtons the gravitational attraction of two masses of 5.3 kilograms and 20 pounds at a distance of 5 meters. The arguments "5.3 kilogram," "20 pound," and "5 meter" are substituted in the function definition in place of the parameters "m1," "m2," and "d," respectively. The expression G m1 m2 / d^2 is then evaluated, and the result is returned to the point of invocation, where the "in" operator picks it up and converts it to newtons. Use of function definitions helps organize difficult problems and saves keystrokes.

Because most computer algebra systems use the LISP language or a variant, it is always possible to define more complicated functions involving loops, conditional tests, and similar operations; details, however, would vary from system to system. I added the one-line function definition described earlier to the muSIMP programming language specifically for this calculating system. A complete language itself, muSIMP embodies elegant modular and block-structured control constructs sufficient for many programming problems.

Temperature Scales

Temperature can be considered a physical dimension such as time or length. The standard unit I use is the Kelvin (K) degree. The other units are:

```
? Co: kelvin;
@: kelvin
? Fo: 5/9 kelvin;
@: 0.5555555 kelvin
```

These are units of temperature change, or relative temperature, and are not meant to be interpreted as temperatures on the Celsius (C) or Fahrenheit (F) scales. Relative temperature units are suitable for calculations involving specific heats. Given the specific heat of water at constant pressure,

```
? specificheatH2O: 1 calorie / gram /
  Co;
@: 4186 meter^2 / (second^2 gram
  kelvin)
```

I can ask how much energy, in Btus, is required to raise 6 pounds of water by 30 F°, assuming the water does not change state:

```
? specificheatH2O 6 pound 30 Fo
  in Btu;
@: 179.9749869 Btu
```

Bear in mind that the Fo in the first line does not refer to the F scale—I am referring to a temperature change, not a specific temperature. (Note: in these temperature transactions, the lowercase o represents the degree symbol.)

To work with actual temperatures in the various scales, I introduce two postfix operators, oF and oC. A postfix operator takes its argument on the left; if I enter

```
? waterboils: 212 oF;
@: 373:16 kelvin
```

the function named oF receives 212 as its argument, interprets it as an F temperature and converts it to K. The functions oF and oC are defined as:

```
? t oF: (5/9 (t - 32) + 273.16) kelvin;
@: oF
? t oC: (t + 273.16) kelvin;
@: oC
```

with t as the single parameter in each case.

That takes care of entering temperatures on C and F scales. To enter K temperature, I use "kelvin" because the K scale is an absolute scale that originates from a temperature of absolute zero and needs no conversion:

```
? nitrogenmelts: 77 kelvin;
@: 77 kelvin
```

Displaying K temperatures presents no problems. If I want to display temperatures on an F or a C

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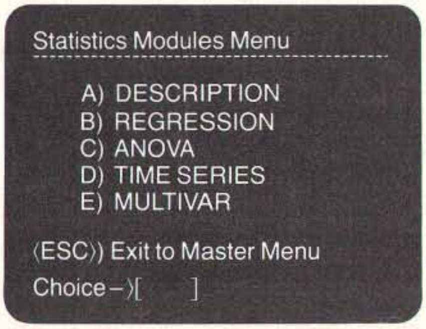

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E) MULTIVAR

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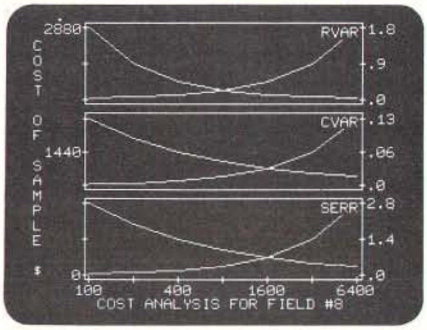

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scale, however, things get a bit trickier. I add logic to the "in" operator that handles the units oF and oC separately. For example:

```
? nitrogenmelts in oF;
@: -321.07 oF
? waterboils in oC;
@: 100 oC
```

The oF and oC units on the right of an "in" cannot be mixed with any other units; they must stand alone as in the above transactions. This restriction does not hold for the units of relative temperature, Fo or Co, which may be combined with other units, as in:

```
? specificheatH2O in joule /
  kilogram / Co;
@: 4186 joule / kilogram / Co
```

Combining temperature units enables me to ask, for example, what is the final F temperature of a ton of water, initially at 20° C, to which 10 million joules of heat energy are introduced:

```
? 20 oC + 10^7 joule / (1 ton) /
  specificheatH2O in oF;
@: 72.7399951 oF
```

Plane and Solid Angles

I handle plane angles by introducing pi and using the radian as the standard unit:

```
? pi: 3.1415926;
@: 3.1415926
? degree: pi/180 radian;
@: 0.0174532 radian
? revolution: 360 degree;
@: 6.2831852 radian
```

I want the normal trigonometric functions, which can be provided by programming them from the relevant Taylor series expansions. After the functions are properly defined, I have:

```
? sin (30 degree);
@: 0.5
? cos (1/8 revolution);
@: 0.7071067
```

The other functions are defined in terms of sin and cos:

```
? tan (angle): sin (angle) / cos
  (angle);
@: tan
? sec (angle): 1 / cos (angle);
@: sec
? csc (angle): 1 / sin (angle);
@: csc
? cot (angle): 1 / tan (angle);
@: cot
```

In these trigonometric functions, the argument must be a plane angle in radians, degrees, revolutions, or similar units. In some mathematical systems, angles are dimensionless quantities with no units. The definition of angle as the ratio of arc length to radius, which is the ratio of two lengths, suggests a simple dimensionless number. But for this system, I require that angles be entered in appropriate units, not as dimensionless quantities; however, trigonometric functions return results that are dimensionless numbers.

Having units of time and plane angle, I can use angular velocities. The moon's orbital period is 29.53 days, so its average angular velocity is

```
? omega: 1 revolution / (29.53 day);
@: 2.4626499 10 ^ -6 radian / second
```

Taking the angular velocity as a constant (which it is, approximately), what fraction of the moon's face is illuminated, as viewed from Earth, 5 days after the new moon?

```
? (1 - cos (omega 5 day)) / 2;
@: 0.2572515
```

I deal with solid angles in units of steradians or spheres. The standard is steradian, and sphere is defined as

```
? sphere: 4 pi steradian;
@: 12.5663706 steradian
```

Mixing solid and plane angles enables me to define a function

```
? cone (theta): (1 - cos (theta)) 2 pi
  steradian;
@: cone
```

that computes the solid angle in a cone of half-angle theta. The argument must be in units of plane angle (because I am taking its cosine), and the returned value would be a solid angle in steradians. Then,

```
? cone (90 degree) in sphere;
@: 0.5 sphere
? cone (1 radian);
@: 2.8883658 steradian
```

Sexagesimal Notation

I find it convenient, especially when dealing with angles or times, to use base-60 (sexagesimal) notation. To enter a quantity such as 4 hours and 36 minutes, I might use the expression

```
? 4 hour + 36 minute;
@: 16560 second
```

However, it would be simpler to enter this as

```
? 4:36 hour;
@: 16560 second
```

The system recognizes that the colon, when between two numbers, is not an assignment or function definition but is a sexagesimal "radix point." The number on the right (in this case, 36) is divided by 60 and added to the number on the left (in this case, 4). The result is 4.6, which in the example is then multiplied by hour, resulting in 16560 seconds. I can take this one step further,

```
? 4:36:30 hour
@: 16590 second
```

in which case I have entered hours, minutes, and seconds. I can do the same with angles.

```
? 15:22:09 degree;
@: 0.2682426 radian
? sin (33:57:20 degree);
@: 0.5585496
```

By appending the appropriate units, I can enter any quantity in sexagesimal notation.

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Summary

A computer algebra system can speed scientific and engineering calculations by carrying units along algebraically and converting them as necessary. For each dimension under consideration, the user introduces a standard unit (seconds for time, meters for length, and so forth) and gives all conversion factors at the outset. At any time during the computation, you can introduce new units or physical constants in terms of the ones already defined. You can also introduce function definitions appropriate to the problem at hand, using them to save time and to help organize the work. The result of any computation can be expressed in standard units (the default) or in any units you want as long as the conversion factors have been introduced and the required units are appropriate in terms of the dimensions of the result. Although the super-calculator might be built around any computer algebra system, it is especially gratifying to have this capability in a personal computer for two reasons.

First, large computer algebra systems require large computers, which are not readily available to individuals or to small groups. Now that computer algebra is available for most popular microcomputers, the costs are low (total hardware and software expenditures could be as little as $2000), meaning that the kind of system I have described would be feasible for almost any engineering or scientific working group, indeed for almost any individual scientist or engineer. The capability to work in any units, without adding time or increasing difficulty, is a convincing argument for the use of such a system. If you consider the algebra system's capability to detect dimensional errors, the conventional scientific calculator begins to look clumsy by comparison.

Second, the hardware used—a Z80 system with 56K bytes of RAM (random-access read/write memory)—is not unusual; in the current technological environment, it's possible to imagine such a system reduced to the size of an 8½- by 11-inch notebook. Portable computers with typewriter keyboards, one- or two-line alphanumeric displays, and sufficient RAM can handle algebraic manipulations. Thus, we can look forward in the next few years to the availability of portable scientific calculators with the kind of algebraic capability I now have in my personal computer. The applications for such a device include computing miles per gallon, figuring current densities in amperes per square centimeter, and calculating the price of peanuts in dollars per kilogram. Each application has its own characteristic units, constants and formulas, and each system could be configured by a user for specific problems.

In the past, computer algebra systems have been used for abstruse mathematical problems with formulas too cumbersome to be dealt with manually. (This is one reason most computer algebra is done on large machines.) Affordable computer algebra systems using personal computers and the techniques described in this article can improve the speed and certainty of calculations and will perhaps make the conventional scientific calculator obsolete in a few years.■

Stuart Edwards is a software designer, consultant, and lecturer. He holds a Master's degree in computer science from the University of Hawaii.

Since submitting this article to BYTE several months ago, I have developed an advanced version of this system that includes a completely new algebra subsystem designed specifically for physical calculations. Write to me at 2993-B Koali Rd., Honolulu, HI 96826 if you are interested in obtaining a copy of the software.

Acknowledgments

Thanks to Dave Stoutemyer and Al Rich of The Soft Warehouse (POB 11174, Honolulu, HI 96828) for giving me a lot of help and encouragement on this project. Also thanks to Natalie Jung for her infectious enthusiasm.

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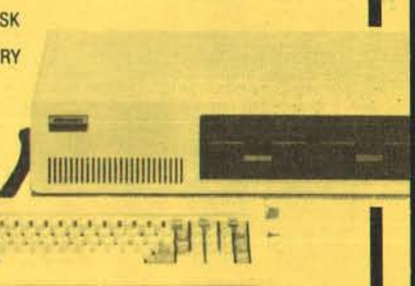

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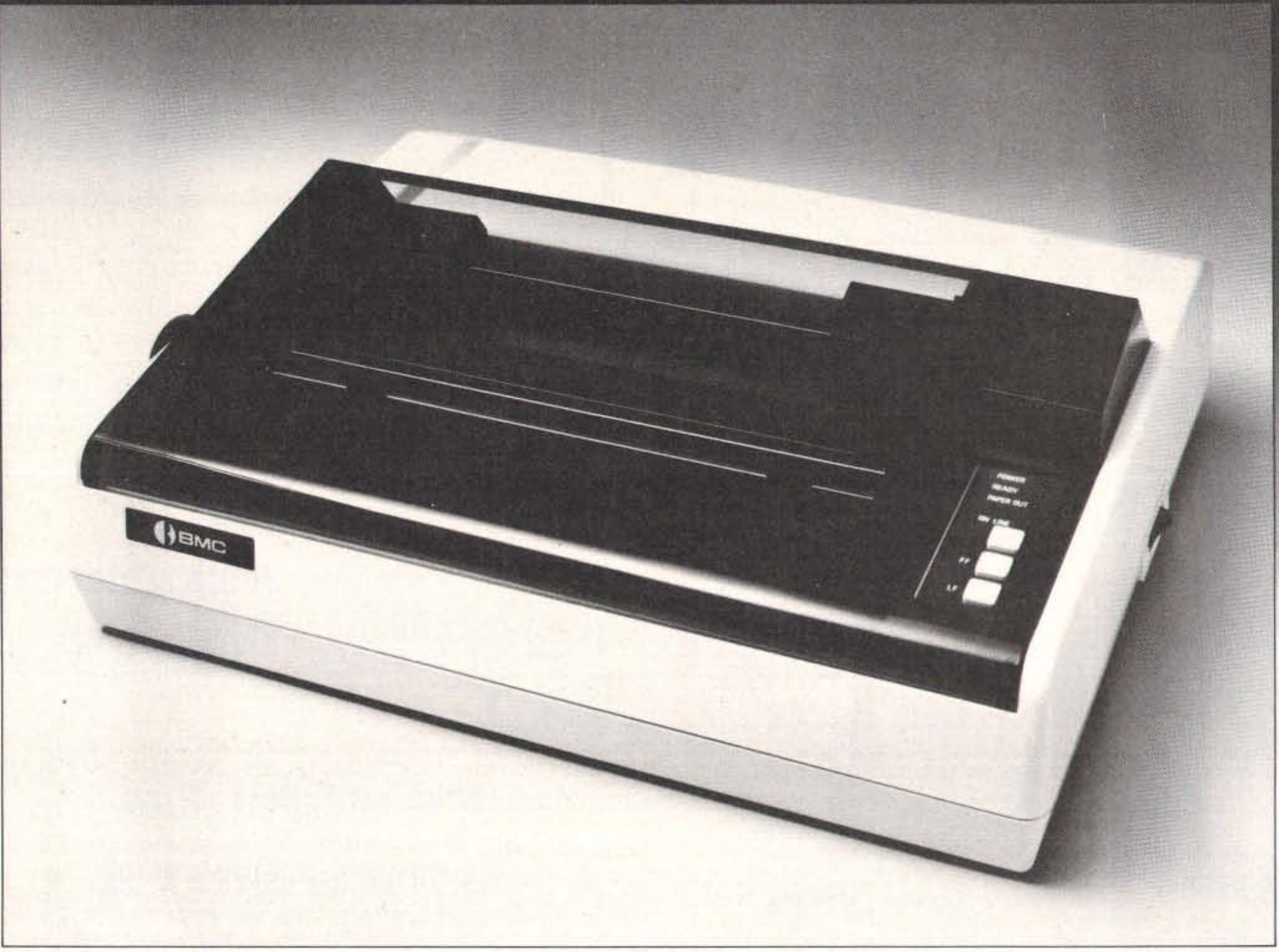

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User to User

Conducted by Jerry Pournelle

From Pascal to Modula-2

Dear Jerry,

In "The Debate Goes On . . ." (August, page 312), you refer to a Modula-2 program that can translate programs from Pascal into Modula-2. I am very interested in a program such as this as we are switching the language used at our installation from Pascal to Modula-2.

Could you tell me how I could get a copy of this program? Thank you.

Dan Stanger
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Alas, I was premature in believing the Pascal-to-Modula program was available. It wouldn't be hard to write, and I'm certain one will be done Real Soon Now.

My apologies for raising your hopes. I'll report on the program as soon as I have one that works. . . . **Jerry**

Dear Jerry,

You have mentioned several times Niklaus Wirth's new book *Programming in Modula-2*. I have tried to find it in the local bookstores (big bookstores, of course), but each of them said they needed the ISBN number. I checked your articles and also the article, "Modula-2," (April, page 385) for the number. Unfortunately, it was never mentioned. I suppose you have that book. Could you please send me the ISBN number? I think you are about my last hope for finding the book within this year.

Danny Backx
Grootreesdijk 124
B 2460 Kasterlee
Belgium

There is a second, corrected edition: the ISBN number is 0-387-12206-0. . . . **Jerry**

Dear Jerry,

I have been fascinated by your comments on Modula-2 and the Sage. I bought Niklaus Wirth's book and have given it a fast first reading. I have visited a Sage dealer in Manhattan and seen his 1-megabyte RAM, 20-megabyte disk model running three terminals. I have written letters to both Sage and Volition (no replies as yet). Now I am hoping that you might put me in contact with some serious users of the Sage/Modula-2 system.

I am trying to evaluate the system for custom accounting and engineering systems that might be constructed from modules that I (and others) would first have to develop. I have been doing this using Osbornes and Victors with dBASE II for local customers. The Osborne's small disk-storage space (even with double density) has always required me to stop the system short of what it might be. The Victor has not been the same problem; however, dBASE II has provided its own rack of difficulties that must be continually dealt with. Although, as advertised, dBASE II has cut application-development time to less than 25 percent when compared to Microsoft BASIC and less than 60 percent when compared to Pascal/M, it is miserable as a language and littered with bugs that Ashton-Tate has demonstrated no interest in fixing. Full-blown COBOL seems too unwieldy for me. The concept of Modula-2 is very appealing, even though I realize that I must develop my own DBMS language before I can use it. That is, unless you have heard of one that will run the Sage and would be better than developing my own.

When I was in Champaign/Urbana, I saw the documentation on a microcomputer-based DBMS called Knowledge Man. It was a DBMS language more elegant than dBASE II and without the constraints. The University of Illinois Information Services had it. No one had yet run it seriously (it is designed for the IBM PC with 256K bytes). Have you heard of or seen it?

Ben Smith
POB 80582
Fairbanks, AK 99708

I first saw dBASE II, then yclept Vulcan, in about 1979. It had the most miserable documentation I've ever seen. One of the users at Cal Tech's Jet Propulsion Laboratories volunteered to write a tutorial introduction to it on her own time. Ashton-Tate bought the program, changed the documents somewhat, and marketed it skillfully. For several years dBASE II was about the best database program available for microcomputer users.

Alas, the program hasn't really kept up. Modern microcomputers are capable of much more than they were when Vulcan was written, but dBASE II has improved hardly at all.

I'm not familiar with Knowledge Man. Within a year I expect to see some really good database programs written in Modula-2 for the new generation microcomputers.
. . . Jerry

Vector Review Requested

Dear Jerry,

I would like to address a couple of issues mentioned in "Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley" (July, page 323).

As for an appropriate nomer for your Compupro mainframe, why not try "Manny" on for size? I realize it may not be elaborate, but it works.

Something I would like to see would be a review of Vector Graphic equipment and software. In the first column of yours that I read, you mentioned that you had heard of Vector's program editor, Scope. I use it quite a bit since I own an older Vector system and do some programming in dBASE II (which has a lousy editor). For someone that does some programming but does not need macros and features found on EMACS and other large systems, it's a good package. Besides that, it's free with the system. The Vector-designed software, especially Execuplan II, its spreadsheet package, is pretty good compared to some others I've seen. I've sold a number of different hardware-software combinations, and the Vector systems have been the easiest to sell, even though they are somewhat more expensive.

Randy Golden
POB 2397
Kilgore, TX 75662

I tried "Manny" but the machine didn't like it. We try to cater to his whims . . .

Some years ago I strongly recommended Vector Graphic equipment, but that was two generations of microcomputers ago; I'm no longer familiar with Vector's hardware or software, and indeed seldom hear much about it. It's my impression that Scope was excellent in its day, but better editors are available now. I don't know whether they'd work with your equipment; my friend Owen Davies, a senior editor at Omni *magazine, had a Vector system with a nonstandard operating system and couldn't use foreign programs with it. He finally replaced it. . . .* **Jerry**

From an Ex Ex-Mon User

Dear Jerry,

I note with interest your description of the Ex-Mon monitor adapter for the Osborne 1 in "Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley" (July, page 323). I feel strongly this device should not be recommended.

I purchased the Ex-Mon in November, when I bought my Osborne 1. Within two weeks (of very delicate handling), the device failed. My monitor screen went blank, the 5-inch screen continued to function (indicating that the computer had not failed), and I trundled my machine back to the computer store.

The setup was under warranty. The store replaced my Ex-Mon device, and told me it had had problems with these in the past, particularly when owners had manipulated the Ex-Mon while the computer was turned on. Apparently this can destroy the device.

I used my next Ex-Mon with complete satisfaction, adding an extra length of cable between monitor and computer so I could plug in the monitor without touching the Ex-Mon adapter. My new one caused no problems, but in retrospect this may be because I hooked up the external monitor only once or twice in the last six months.

The end of the dream came a week ago. I set up a computer station in my home office and plugged in the monitor. The computer and monitor worked well. I rearranged the wiring, unplugging the monitor in mid-cable to do so. When I plugged it back in, the monitor died; that is, the adapter died. Apparently it is more fragile than I thought.

I went back to the store. "Yes," the manager said, "we've had five or six of those that have self-destructed." That seems a lot for a small town such as Napa. I have no information regarding the failure rate of the Ex-Mon, but it seems to be high.

My computer store says another company makes such a device. If I can find out who it is, I will write you that information. If you find out who it is, please put a note in your column.

Dan McMahon
4590 Dry Creek Rd.
Napa, CA 94558

Alas, I have had several other letters with similar complaints. Our unit has worked for about a year with no trouble, but I confess we don't use it continuously because we have a regular Osborne large screen as well.

I'd be glad to try a similar product from another company, but at the moment I don't know who makes them. Perhaps the Osborne User Group would know. . . . **Jerry**

99/4A Notes

Dear Jerry,

Thanks for kicking TI in "Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley" (July, page 323). Like you, I owned one of their calculators—the SR-56—with 100-step programming and always thought highly of it and TI.

The difference between the calculators and the 99/4A turns on the observation that we could make the calculators do everything they could. Not so with the 99/4A, yet it seems not surprising from the perhaps mistaken viewpoint that the 99 is really a ROMed-up version of the TI 990 computer system.

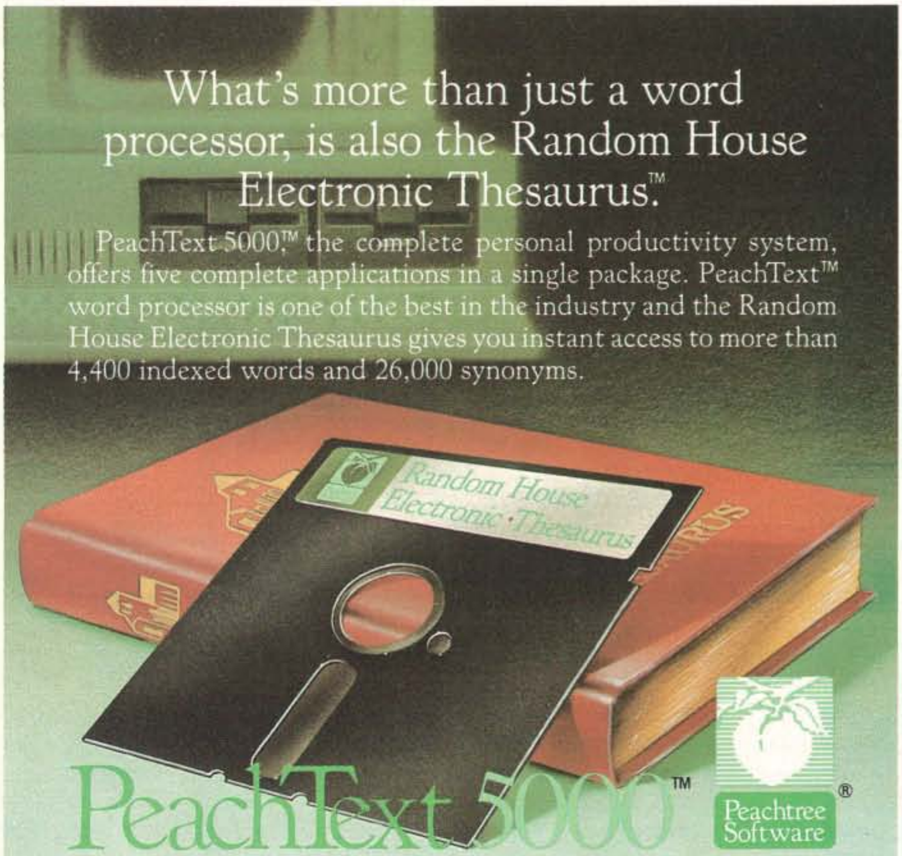
If the 99/4A is really just part of that series with a clumsy BASIC-GROM system, it seems imperative that these third-party software people get hacking on a chip-replacement set for the operating system. There are three reasons:

First, it looks like an inexpensive concurrent computer is right on the shelves (the 99/4A is $70 at local stores). Second, it seems to be the most direct approach to both the third-party licensing and hobbyist problems with GROM/GPL. By replacing GROM and the OS with a relocatable OS monitor, TI might just have to back down. (A software-interrupt driven 9900 is very attractive and *it's right there to be taken.*) And, more personally, as a newcomer to owning a computer, I resent being sold a system with a resident GROM.

Anyway, here are some books that point to better things:

For an explanation about why the 99/4A is really a 990 and, interestingly, a floppy-disk control program, use *Microprocessors/ Microcomputers/System Design* published by McGraw-Hill.

For a glimpse of a concurrent 990 (and therefore, 99/4A) as well as what might be a description of where GROM came from, read chapter 5: "Component Software" from *Software Development* (TI #MPA29).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For a tutorial with software and hardware theory and explanation, read *Fundamentals of Microcomputer Design* (TI #MPB30A) and *16-Bit Microprocessor Systems,* published by McGraw-Hill.

I bought these books to augment TI's Editor/Assembler manual. For learning assembly language they've been a great help. However, it'll take real expertise to do anything about the 99/4A. I hope that the right people will get working. It'll be a while before my 99/4A deserves a name; I'm jealous.

Frederick Hawkins
1020 North 6th St.
Allentown, PA 18102

We've yet to get a TI 99/4A, although I intend to buy one so that I can include at least a few words about it in upcoming books and columns. You obviously know a great deal more about the TI machines than I do; I wouldn't have the faintest idea of how to replace the operating system, and I don't advise anyone to try it.

However, if there's anyone out there who's both mad enough and expert enough to accomplish this, I'd love to hear from him.

Thanks for the tip on books. (See Jerry's article, "The User Looks at Books," on page 519.) *I haven't seen those yet; given the explosion in computer books, it's nearly impossible to keep up. . . .* **Jerry**

Simplifying Structure

Dear Jerry,

Structure, structure, and more structure. There is no such thing as a structured programming language, just structured programmers.

I see no use in a language that won't let you do something that needs to be done, just for some arbitrary rule of structure. I'd rather see a language that cooperates with the programmer in the solution of a problem and leaves structure and organization to the programmer instead of a language that fights the programmer if he or she tries to use the language any way other than the way it was written.

Example: I specialize in taking applications programs that run nicely on a big expensive mainframe and trimming them down to run on a small mini. I want a language that will cooperate, not give me more of a problem.

Of course, the programmer must develop certain techniques to self-structure his code, or, as you point out, the program cannot be maintained. My point is, it should be the programmer who structures his or her code and the language to execute it, not the other way around. A programmer's style evolves, as do his or her skills.

M. W. Cocke
246 West Upsal St.
Philadelphia, PA 19119

Certainly programming style evolves; I was just working on my old Star Trek game and I discovered a number of horrors I'd put in it.

The question of language limitations is important. Marvin Minsky of MIT decries Pascal because it is, as he says, a voluntarily worn straitjacket. It prevents you from doing certain things in the most convenient way. The payoff is that later you will have a much better chance of remembering exactly how you did what. More to the point, someone else will have a fighting chance of understanding what you did.

I once saw Minsky write a Turing Machine simulator in APL. It was a single line of about 80 characters of code. In APL, a single character can stand for "Invert this matrix" or something equally complex. There was no chance that Minsky or anyone else would ever be able to modify that program.

If all your programs are for your own use and will never be maintained or modified by someone else; if you can guarantee that you will not abandon the programming language for a new one, but will stay familiar with it; and if you'll never want to incorporate elements of old programs into new ones you're writing, then you should probably use the most flexible language possible.

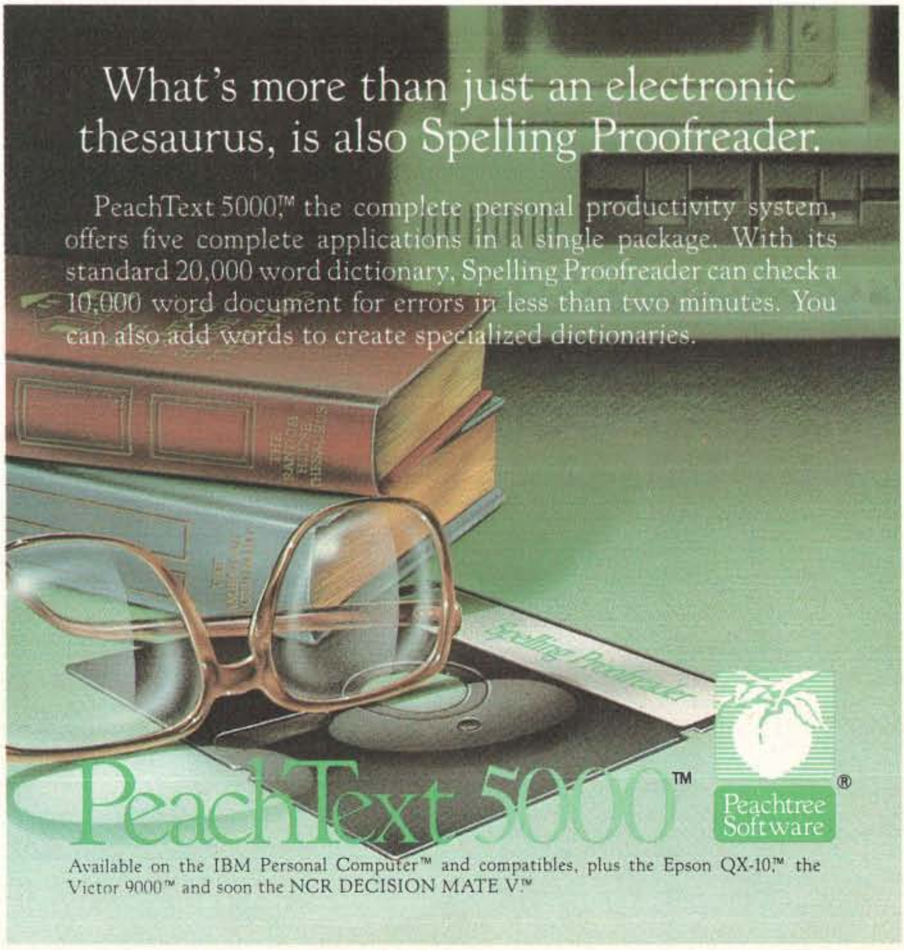
I'm not overly pleased with many of Pascal's limits myself, and I admit that I do most of my programming in CB-80 because Pascal's peculiarities tend to infuriate me. However, since we're switching to Modula-2 here at Chaos Manor, a lot of the Pascal debate has become moot.

Do recall that my columns are largely oriented toward the user. I'm always pleased when a professional programmer finds something to like. . . . **Jerry**

A New Warranty

Dear Jerry,

This letter involves the dreaded software licensing agreement. You have had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occasion to get upset about the nonsense that is usually contained in these things, and so have I. This led me to have a little fun with them, as seen in the "Viewpoint" column that I wrote for the February 28, 1983, issue of *Infoworld*. My hope was that people would start enclosing copies of this warranty with their payments to software companies. It didn't happen, but life goes on.

Dave Wilson
635 Wellsbury Way
Palo Alto, CA 94306

For those who didn't see it, Mr. Wilson's hilarious "warranty" of the check accompanying payment for software included such terms as "This check is valid for 30 days. Should the paper it is printed on disintegrate, you be sure to let me know" and "This check is provided 'As Is' without warranty, either express or implied, including, but not limited to, the implied warranties of financial value or liquidity. The entire risk that this check can be cashed, or even that it is drawn on a bank that actually exists on the planet Earth is assumed by you. Should the check prove defective, you—not I—assume the entire cost of all necessary, but fruitless, efforts at reimbursement."

I too regret that the micro community didn't adopt his "implied warranty" which, naturally, became effective when the check was cashed. . . . **Jerry**

Two for Public-Domain Pascal

Dear Jerry,

You asked for information in "Epson QX-10, Zenith Z-29, CP/M-68K, and More" (August, page 434) on how to get the public-domain version of UCSD Pascal running on a system using a Compupro Disk 1 controller. Unfortunately, I have been having problems getting Version IV.0 UCSD p-System from Softech Microsystems running using the Disk 1. If the two versions are similar enough I may be able to use information about the public version to get the commercial version running. Let me define my problem.

The computer I have been working on has a Z80 processor, 64K RAM, a Compupro Disk 1 single-density/double-density disk controller, and two 8-inch disk drives. The operating system is CP/M 2.2, which uses the Compupro-supplied GBBIOS with changes only in the console and printer routines.

First I tried to use the PASBOOT program to boot up the CP/M-adaptable system. Since the p-System disks were single density, it was necessary to recalibrate the drives before trying to read the secondary booter, which refused to be read anyway.

Next I obtained a working p-System disk from another computer. I changed the PASBOOT program to include disk routines from the Compupro-supplied GBBOOT program. I also modified the GBBIOS to do only single-density reads and to run below CP/M at B800 hexadecimal. The attempt to boot was partially successful and the secondary booter was read in, but an error, "Can't find SYSTEM. PASCAL,'' occurred. Since the same disk will boot up on its own with other computers, I assume that this file is present. The interleave and skew values I used are correct for this disk. There were also no errors occurring during the BIOS disk routines.

I wrote both Compupro and Softech Microsystems and was told that the problem is a nonstandard BIOS and that I will have to use the full-adaptable system.

If you receive or already have information on getting either version of Pascal running, I would appreciate it greatly if you would send it to me. I would especially like to receive a working SBIOS for use with the Disk 1.

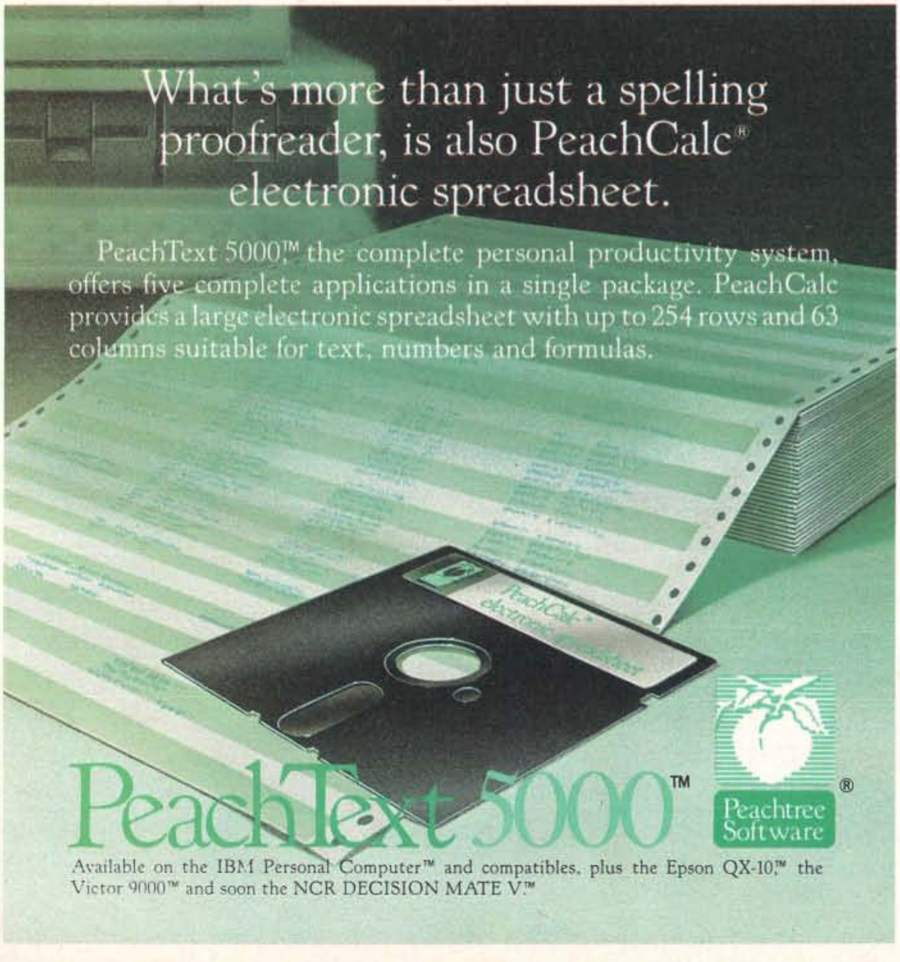
Dwight Irving
Chemistry Department
University of Idaho
Moscow, ID 83843

Alas, your problems are typical of others reported to me. All I can say is that there is a version of public-domain UCSD Pascal running at Cornell University; but so far, no one has shown me how to get it operating on my machine. I keep hoping. . . . **Jerry**

Dear Jerry,

If you successfully get the public-domain UCSD p-System up on your Compupro, will other users like me be able to do so? In other words, will somebody please document the installation so the rest of us can install it also?

I am the service manager of a small computer dealership (Apple, DEC, Osborne, Victor, and add-ons). I have grown accustomed to the Apple version of UCSD/p and recognize the value of its transportability. I have seen the Sage in action and would like our store to carry it (no floor plan for it yet, or we would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have it now), which would mean more exposure to UCSD/p. Both Victor and Osborne have versions of the p-System up and running. This means that my job will soon involve answering questions about the p-System, and I would like to give customers the right answers from my experience. I am also rather fond of Pascal.

It was my intention to buy the general version of the UCSD p-System from a vendor in San Diego, try to hook onto the CBIOS of C/PM-816, and see what happened. If there is an easily installed, public-domain version of the p-System, I am *very* interested, even to the point of getting it, installing it, and making the installed version for Compupro 816 public. I had not even heard of a public version until your mention in the August User's Column.

Ed Karns
Executron Systems
628 East Washington St.
Petaluma, CA 94952

I really know no more than that a Cornell University professor told me there was an S-100-bus version of UCSD Pascal and that it was legally available.

A number of people I respect are fond of UCSD Pascal and its operating system. As I've mentioned before, Carl Helmers, former editorial director of BYTE, has five Apple computers running UCSD Pascal; he's so fond of them that his personalized automobile license plate reads "P CODE."

If I learn anything more, I promise I'll feature it in the column. . . . **Jerry**

What's the Next Bus?

Dear Jerry,

The S-100 bus has served long and well, but as you well know the day will soon be upon us when 32-bit microprocessors are relatively inexpensive and multimegabyte RAMs are within the reach of homebrews without having to sell the furniture. It is useless to pooh-pooh the idea with comments like, "What will one do with all that power and memory," as the ideas and applications will rise to the challenge. (You only have to think back a few years when 16K became available for a micro.) Given the limitations of the S-100, where are the hackers going to migrate?

I am not asking for a specific answer but thought that this subject would be appropriate for discussion reviewing the merits and disadvantages of the Multibus, Versabus, VME, IEEE-896, "Futurebus," et al.

I am already thinking about the VME, and from what I have read, I think that this may be the best. Obviously, my thinking is irrelevant, as I would have to follow the manufacturer's offerings.

Justin Farnsworth
65, rue Chauveau
92200 Neuilly
France

I agree that the question is more than interesting. I don't have an answer. My friend and associate Tony Pietsch developed a project known as the PI Buss, which he claims has advantages over all the others, but I don't know who would develop and market it.

Perhaps some other readers will have more information. . . . **Jerry**

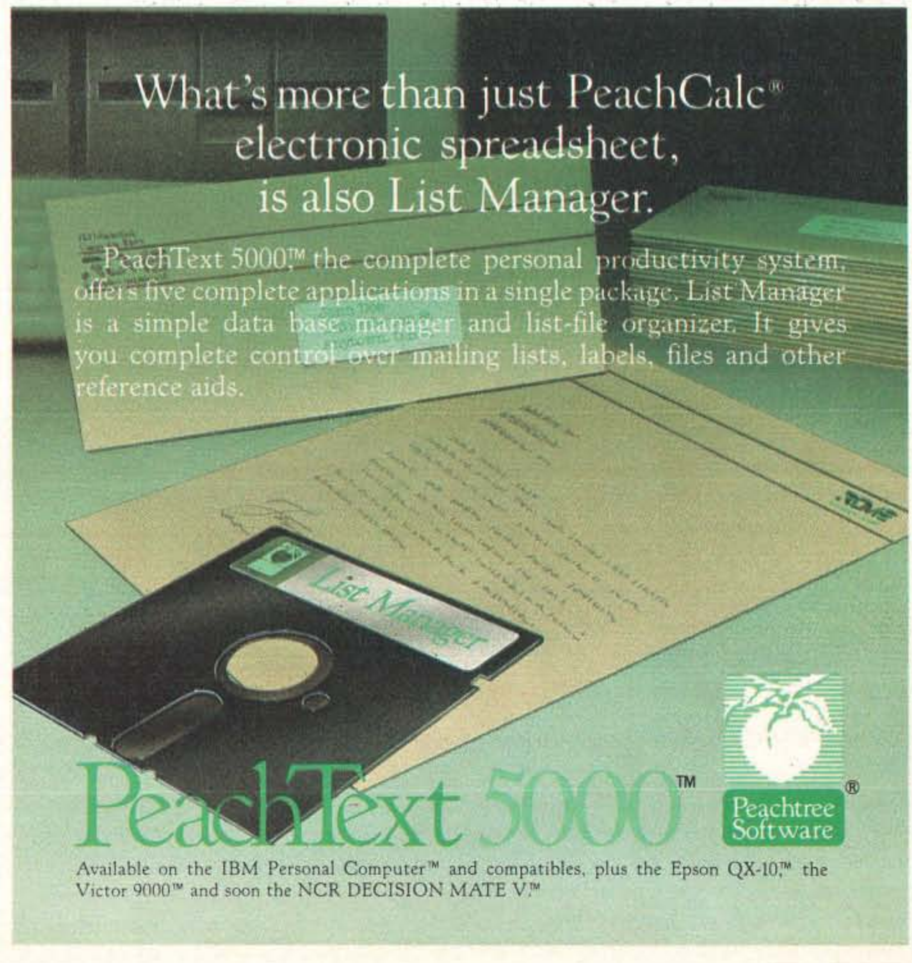
Three Busy Bees

Dear Jerry,

You have said several times that you hope the computer market is never fully sewn up by large companies. I wonder if I might trouble you for an opinion for a "garage company"? I daresay that our situation is, if not unique, then far from ordinary. We keep getting kicked out of the garage by our parents. If that seems like a rather unusual company, allow me to explain.

The company is B, B & B Electronics (1 Jill Dr., Carnegie, PA 15106), named for the three of us foolish enough to propose a company. We do not legally exist as a company and two of us are still minors. This didn't stop us from pursuing computer design over the last three and a half years. Before we graduated from high school last spring, we succeeded in getting our first micro running without any formal training and without assistance beyond the kindly loan by U.S. Steel of a ROM-burner. In recent months we have redesigned our machine, and it is now a self-contained, if jury-rigged, affair that no longer requires an external terminal. We are sufficiently happy with what we now have to refer to it as our "prototype," even though we have no way of producing or marketing it.

While we iron out a few minor bugs, we are casting about for ideas to add a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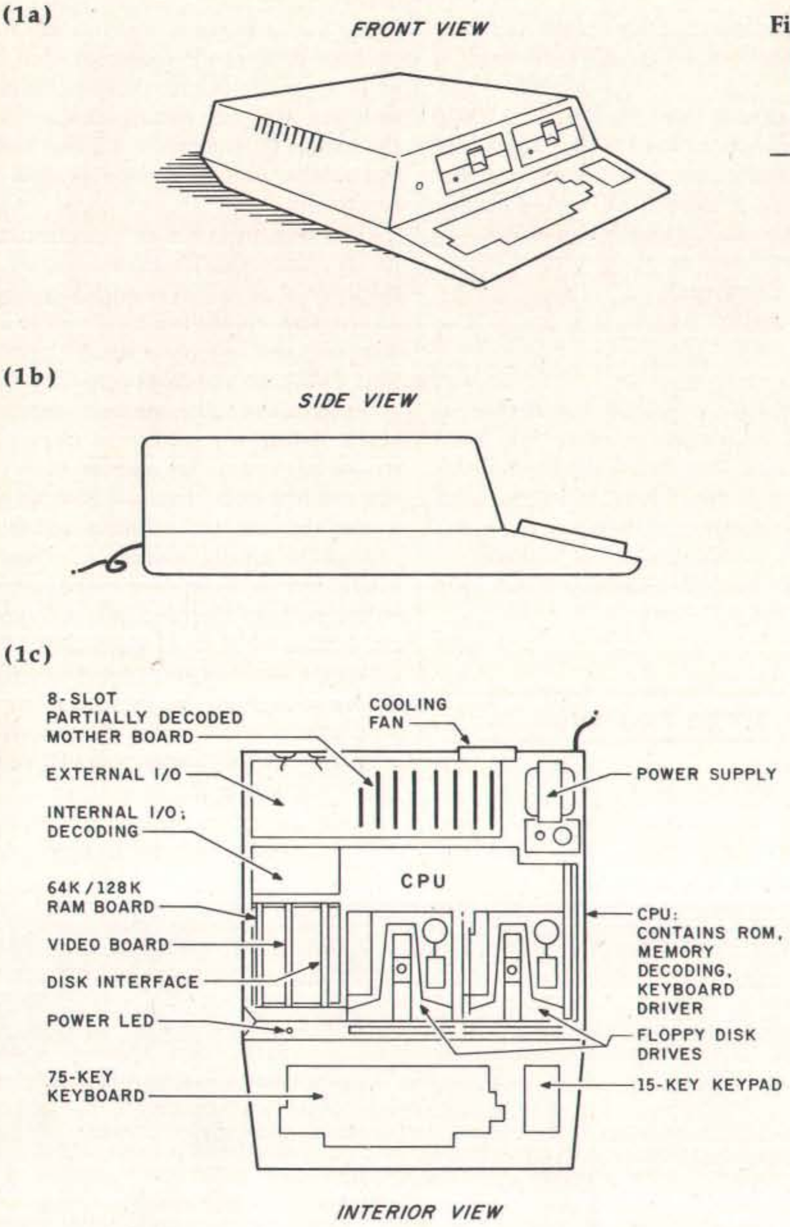

Figure 1: *The proposed production model of the BBB-1.*
1a: *The front view showing dual floppy-disk drives.*
1b: *The side view showing relative proportions.*
1c: *The interior view of the homebrew computer.*

special touch to our machine that might interest somebody in the design. Meanwhile, we've had a great deal of fun and learned quite a bit in the process. People who congratulate us are never turned away, and advice offered is accepted with open minds (even if we do promptly discard it). With this in mind, do you have any suggestions or criticisms to offer us?

In the optimistic days, before it was demonstrated to us that building a computer was impossible, Bob Barker (*not* the one on TV, but the first B in our company) and I agreed to send you one of our first production models (see figure 1).

The system we have now is a Z80-based microcomputer with 64K or 128K of dynamic RAM, 16K of ROM, and 2K of video RAM. We have a 90-key keyboard (see figure 2) on the drawing board shown with the proposed key layout, meaning it's what we want, but can we find keycap manufacturers who have the proper legends? You may recognize the layout as being drawn almost directly from the H-19, of which the three of us are fond. We can actually use any key layout by reprogramming the keyboard encoder; at present we have a stock Jameco keyboard on the prototype.

The video screen is currently 25 lines of 64 characters, which will change to 80 characters if we ever get around to buying a faster crystal. The display is generated by the MC6845 video-display chip found in the TRS-80 Model II/12/16. (By the way, did you know it's possible to pro-

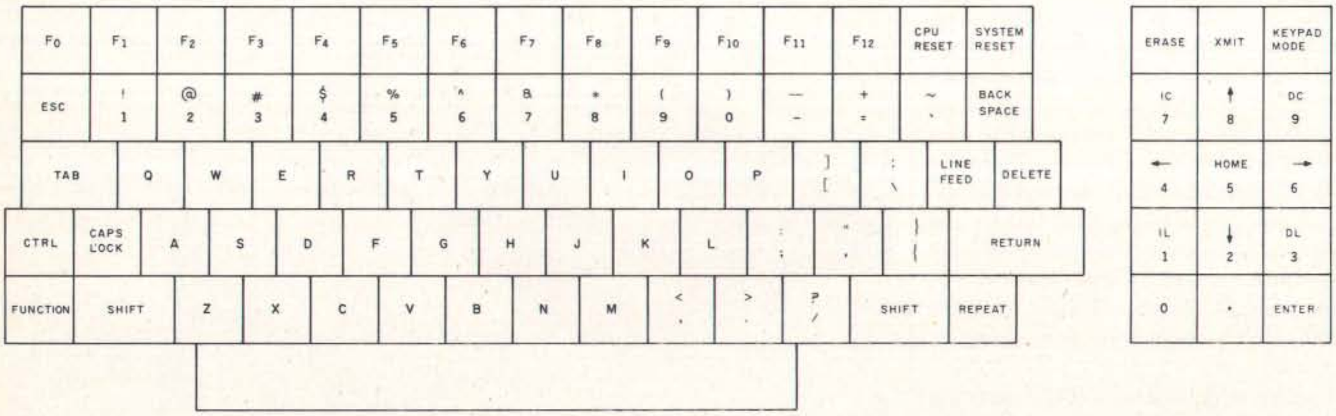
F0 F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12 CPU RESET SYSTEM RESET
ESC ! 1 @ 2 # 3 $ 4 % 5 ^ 6 & 7 * 8 (9) 0 — - + = ~ ` BACK SPACE
TAB Q W E R T Y U I O P] [: \ LINE FEED DELETE
CTRL CAPS LOCK A S D F G H J K L : ; " ' | { RETURN
FUNCTION SHIFT Z X C V B N M < , > . ? / SHIFT REPEAT
ERASE XMIT KEYPAD MODE
IC 7 ↑ 8 DC 9
← 4 HOME 5 → 6
IL 1 ↓ 2 DL 3
0 . ENTER

Figure 2: *The keyboard of the BBB-1.*

gram a Model II/12/16 to burn out its own monitor?) The 128-character set is produced by an 8 by 8 matrix copied largely from the character set of the Ohio Scientific Superboard II of days gone by, plus their reverse video complements. The ways in which we revise the video section depend on whether the machine will be intended for use on TV sets or not.

Something else not yet worked out is disk storage, but Bob is working on it. He also modified the memory decoding and bank switching to allow CP/M Plus; he and Roger Brockenbrough (the third B) have agreed that implementing such a system and developing a CBIOS will be my job. (They make me do all the software; I wrote a BASIC interpreter, machine monitor, and a cassette-operating system.)

The software is in ROM at present: a tiny BASIC I'm almost afraid to admit having written, a monitor hardly above the OSI C1P stage, and the I/O support routines. On initialization, these programs all bank-switch themselves nicely into RAM so the user never sees the ROM. This transfer, with the Z80 block-move instructions, is too fast to even notice on reset.

Since the summer has gone while we worked and we are out of high school, things are starting to wind down for our grand and glorious ideas. By the time we get out of college, however, our knowledge will no doubt be out of date. We predict our current design to be laughably outdated within a year or two at the most.

Please do not criticize our lack of Microsoft BASIC. Last December we wrote a respectful letter to Microsoft asking if we could possibly license any existing BASIC at all, to which they never responded. I then wrote my own, which I hope I never have to do again: it's murder! Also, my end product is only marginally more developed than the tiny BASIC found built into some processor chips (such as the Z8671). Rest assured that we would never even think of marketing any product with my current BASIC 1.3 in it.

Mark Bereit
343 Rockfield Rd.
Pittsburgh, PA 15243

I'm impressed. I doubt you chaps will have any problems finding suitable positions in the computer world.

The days of fortunes made through new full-blown computer designs built in a garage for a few hundred dollars are, alas, just about over. Wozniak and Jobs (Apple) and David Jackson (Altos) obviously had the right ideas—but they were also supremely lucky in their timing.

There are still openings for after-market equipment for popular machines like the Commodore 64, Atari, IBM PC, and such, and a very good market exists for IEE-696 (S-100) boards that do new and different things. Most successful garage companies, though, will probably involve software. . . . **Jerry**

Languages of Choice

Dear Jerry,

I am an engineer and not a computer scientist. As an engineer, I am interested in using and writing programs that solve problems, not programs that are works of art. These tend to be much larger than your typical one-run on a microcomputer, generally running from 1000 to 20,000 lines of code. In addition, they may handle amounts of data up to 100,000 numbers or more in an iterative fashion. I have to be concerned with cost to my client, so speed and the charges are important, especially since computer charges may be 10 to 50 percent of some of the studies that my company does. As computers become more powerful, we will find more problems to use that extra power. Currently, certain studies that we would like to do are not economical and would require a 10-fold drop in computer charges before we can consider them.

Now, engineers use FORTRAN (that language hated by you and computer scientists) not to spite anyone and not because of tradition, but because it has two major advantages besides speed of execution. The first is *portability*. When programs are written to closely adhere to the ANSI 66 (or 77) standards for FORTRAN, it is easy to move programs from computer to computer. For example, a team of two engineers moved a 50,000-plus-lines civil-engineering program from a Honeywell (36-bit word) to a Harris 500 (24-bit word) in about four hours of editing and compiling. I have worked with programs written by research organizations for computers other than the one I use, yet I only have to change 4 to 10 lines (clearly identified in documentation) out of 10 to 20,000 lines of code—and then have it compile and run correctly the first time. We have had a 3000-line program (written by our company's engineers) on

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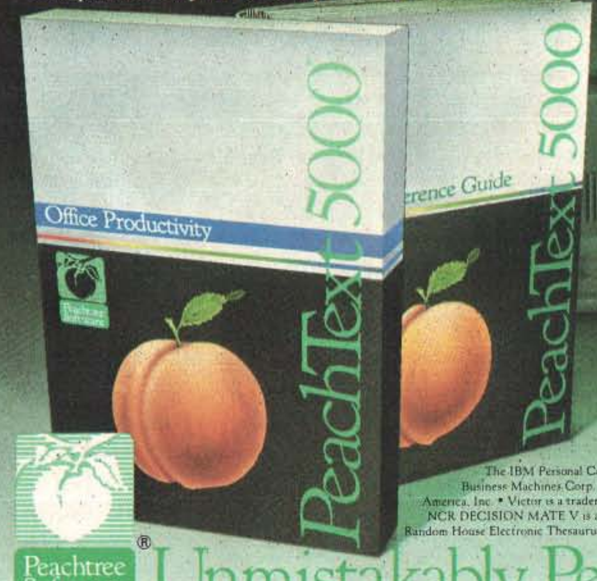

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five different computers and compilers in the last year and a half—and it can typically be brought up in less than 2 hours. How many of your favorite languages are available on as broad a range of computers and capable of this degree of portability?

The second major reason is *dynamic dimensioning of arrays.* First, subroutines can receive arrays of any size and shape.

```
SUBROUTINE (ARRAY, M,N)
DIMENSION ARRAY (M,N)
```

Granted, this can lead to errors in the hands of the careless, but it also allows a powerful library of standard subroutines to be built up (for example, the IBM Scientific Subroutines Package in the public domain), compiled, and then kept in a library. These subroutines are source-compatible with any ANSI standard FORTRAN compiler, thus reducing the amount of work that the user must do.

Also, multiple arrays can be allocated out of a large pool vector after a few parameters are entered for the problem. Since these parameters can change from run to run (thus changing the size of the arrays), the use of a pool means that we do not have to edit and recompile the program every time certain parameters change—as they constantly do in engineering. Before I implemented this feature to a program, we had to recompile one program once a month (a 4- to 6-hour job)—now it is once a year, when we add a new feature to the program.

I know that subscript checking is nonexistent in standard FORTRAN and its string-handling capabilities are abysmal, but I can live with this more so than I could with the array limitations and nonportability that you are finding in Pascal. Currently, the only language that might possibly replace FORTRAN is C, and only if enough companies accept the de facto Bell-standard version.

I also know of your dislike of Microsoft BASIC on microcomputers, but its dynamic arrays and flexible Chain (which lets a program modify itself) allow it to be used in ways simply not possible with CBASIC or any other BASIC. I do not know of any other version of BASIC or any other language on 8-bit microcomputers that will allow me to do what I can do in my POL/PS. (See Mark Finger's three-part article, "Problem Oriented Language," in BYTE, December 1982, January and February 1983.) I noted the problems of unreadable code and line numbers per line, but instead of abandoning the language, I wrote a series of utilities that allows me to have relatively readable code with comments yet do development more easily than with a compiled language. These programs have been released to the public domain (under the typical public-domain copyright limitations—that is, not for resale for more than a small copying charge). I will still furnish them for the $30 indicated.

I envy those versions of BASIC that have local variables in their subroutines, but CBASIC is best used in business-type applications where the general data structure and size are known beforehand. In technical areas, the dynamic arrays and self-modifying features (to incorporate a user-defined equation, for example) are more important.

Mark Finger
2439 Overlook Circle
Lawrence, KS 66044

I don't hate FORTRAN. When I was a graduate student, we had to program the IBM 650 in machine language, and we would have sold our chances for graduation for FORTRAN.

However, I still don't recommend FORTRAN as a language microcomputer users ought to learn. Its portability is commendable but applies largely to mini and mainframe computers; microcomputers have the usual problems of disk-format compatibility and disk file structures to add to the confusion. And the array problem in Pascal is certainly severe; I've cursed it often enough myself.

However, most computer users will begin with interpreted BASIC. When they grow weary of that, they look for a compiled language. I simply would not recommend that their first choice be FORTRAN.

Those who already know FORTRAN from larger machines are often disappointed when they discover the limits of most microcomputer implementations but are usually able to adjust. That's fine for them. FORTRAN is likely to be the language of choice for many special applications, too.

Your impression of compiled CBASIC (CB-80) is incorrect. CB-80 permits dynamic arrays, has an excellent library manager for precompiled code segments, and has chaining at least as good as Microsoft's MBASIC.

I remain unrepentant: FORTRAN is not what I'd recommend microcomputer users learn when they tire of BASIC. Go out and learn Modula-2. That's *the wave of the micro future.*

Where in the world did you learn to lump me in with the computer scientists? . . . **Jerry**

Software Before Hardware

Dear Jerry,

In regard to your statement in "Zenith-100, Epson QX-10, Software Licensing, and the Software Piracy Problem" (June, page 411): "The one thing you won't persuade me of is that you've much chance of handling the records of 100,000 policy holders on any kind of microcomputer I'm going to see in the next few years."

Sorry, Jerry, but Advanced Management Systems Limited (a New Zealand company) has developed a complete package of software for the DEC LSI-11/23 microcomputer, including operating system, compilers, editor, database system, etc., that will support up to 40 terminals on a 256K-byte DEC LSI-11/23.

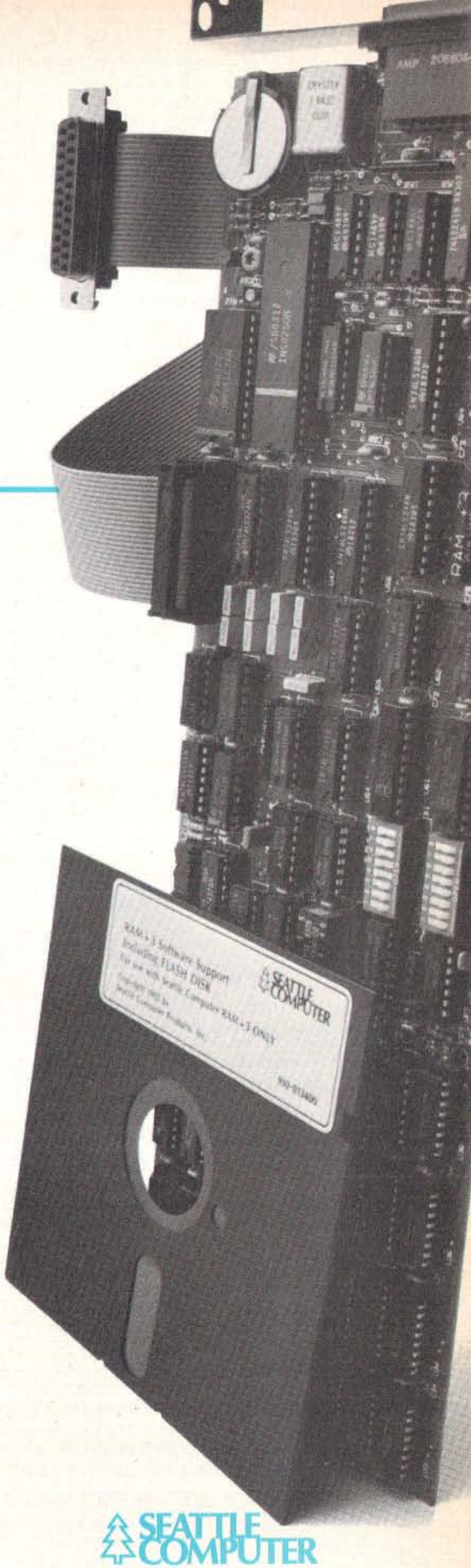
We call this package AMPS (Advanced Management Programming System) and believe it has more advanced features than most mini and mainframe systems. The first application for this software was for Royal Insurance, which has over 100,000 policy covers on its New Zealand head-office computer. Royal has one LSI-11/23 computer in each of its six main branches.

In case you consider the LSI-11/23 to be a minicomputer rather than a micro (although DEC calls it a micro), it is worth mentioning that we intend making a version of the software for the 68000, and I am confident it will be able to support a hundred terminals.

It is my contention that virtually all manufacturer-supplied software is grossly inefficient and wastes 90 percent or more of the computer's power. This has been demonstrated by developing an on-line system on an IBM 370/135 that runs over two hundred terminals, as well as by the AMPS software on the LSI-11/23. In each case, the manufacturer's software will support only about one-tenth this number of terminals.

The days of the big mainframe computers are numbered, as Intel, Motorola, and National Semiconductor bring out chips with more and more power. Existing software available on 16- and 32-bit microcomputers is generally inefficient also. With good software, machines like the 68000, the DEC 11-J, the 80286, and the NS-32 series will totally collapse the computer market, as they can economically cover the whole range of products from single-user micros to superminis and medium-sized mainframes. For larger systems, the most economical solution will be to use multiprocessor versions of the

TIC TOC WE'VE GOT THE CLOCK



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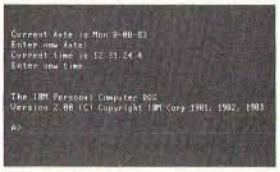

```
Current date is Mon 8-08-83
Enter new date:
Current time is 12:31:24.4
Enter new time:


The IBM Personal Computer DOS
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A>
```

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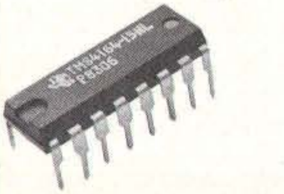

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same machines.

The real changes will only occur, however, when computer users learn to choose their software and then get some hardware that works with it, rather than the other way around. The prime-number benchmarks published by BYTE amply demonstrate that the variation in application-execution speed using different compilers for a given machine varies by a factor of 1 to 1000, which far exceeds any hardware price/performance variations. Programmer productivity also varies by a factor of more than 1 to 10 on different software, again indicating that the software should be chosen before the hardware.

R. Tomes
Advanced Management Systems Limited
11 Huron St., POB 33-726
Takapuna, New Zealand

Of course I consider the LSI-11/23 a minicomputer, and so would just about anyone else.

However, I agree that I was rash in my statement; the Sage IV with hard disk can already manage 100,000 policy records, and I'm rewriting my "Minimum Data Base" to allow it to do much the same thing (although I've no need for that *many records!).*

I can't recall why I ever said a silly thing like that. I wrote it in December 1982 (the pipeline was much longer then; it's down to a couple of months now), but alas, I knew better then. Perhaps I can plead too much Christmas cheer? Stay well. . . . **Jerry**

For Your Information

Dear Jerry,

In addition to the deficiencies of Superfile, which you have already mentioned in "Terminal Solutions, Manual Madness, BASIC Bits, and Info Helpers" (April, page 324), there is one more I have never seen reference to in print: the program does not prevent one giving a file an illegal name.

Some months ago I was called to the rescue of a friend who was having problems: "I used the Superfile utilities program to rename a file, and I can see the new name in the directory, but when I try to do anything with the file, the computer can't find it." It took only a moment to see what had happened: my friend had specified the new name as "MAIL LIST" (including the space), and Superfile had accepted this, although the final "T" had then been dropped, producing a file named "MAIL LIS" (still with a space). Any subsequent attempt to read, print, rename, or even erase the file then simply resulted in the message "MAIL?" or "NO FILE," since CP/M saw the space as marking the end of the filename and was looking for a file called "MAIL." Since we did not have DU (disk utility) or any similar program on a disk of the right format, the only thing I could think of was to make sure all the other files on the disk had a file type in their names, do "ERA *" to get rid of this otherwise inaccessible file (fortunately it was the index file rather than one of the input files), then run Superfile again on the original files.

You might like to make your readers (and FYI Inc., if it doesn't already know) aware of this additional problem.

Alan Beagley
322 Birdwood Terrace
Toowong, Queensland
4066, Australia

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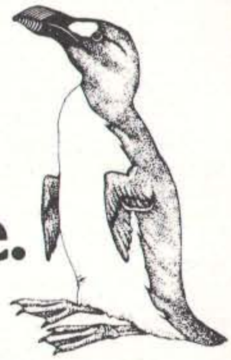

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are that allow illegal filenames? Microsoft BASIC will allow you to give a lowercase filename; that can't be accessed, renamed, or erased from within CP/M, but at least BASIC can get at it. It's simple enough to write a function that will check to see if a filename is legal, but alas, many programmers don't do that. It's especially important to check this when your program has utilities that allow renaming a file.

DU, Spat, and other such programs will allow recovery from such errors. They're available from Workman and Associates of Pasadena, California, or the CP/M user group. . . . **Jerry**

Software Disasters

Dear Jerry,

I am writing this to give you a little ammunition, I hope, to try to get something done about the terrible situation regarding software for microcomputers that has developed just in the past year, as far as I know. I am referring to the several licensing absurdities you have written about recently, and other concerns. First, the usual absence of clear statements regarding exactly what other software and peripherals a given program will work with. Second, the (illegal) disavowal or disclaimer of responsibility to correct bugs, even if they render the program totally unrunnable. And third, the refusal to publish or otherwise release source code that is required for other companies to create or update their own products that were designed to run with the first-mentioned software.

Since March I have paid $450 or more for software, *all of which was advertised in BYTE,* none of which I can use. I have to blame myself somewhat for lacking the patience in all cases to ascertain what a given program will do and run with. But then, I don't have the time to do very much of this, and waiting for gaudy and optimistically worded advertising brochures to be sent on my request is very often an exercise in futility.

I suggest several solutions. First, the legal solution would require that every piece of software sold commercially have explicit statements about what environment it will run under and also state the known environments that it will not run under, given the context under which it was bought. Second, the computerized bulletin-board systems that are now common throughout the country could be used to spread information about specific products to point out those programs with bugs or those that will not run with whatever. Third, BYTE could maintain a file of comments on commercial software products that it could sell, for a nominal profit, without necessarily claiming accuracy for the specific comments.

Mark A. Melton
5329 Rex Ave.
San Diego, CA 92105

The problem is important, and it won't just go away. However, I don't believe that what we need is additional regulations or laws; the result of that would be to stifle the computer industry. In particular, regulations keep the small entrepreneur from entering the market at all, since he can't afford the lawyers and contract-compliance officers to deal with a highly regulatory environment. We could use some common sense all around: buyers, distributors, publishers, and advertisers.

Alas, the fact that a product is advertised in BYTE, or any other magazine, is no guarantee that it works—or indeed that it will be delivered on time. Magazines operate under severe restraints; they can't refuse advertisements without being prepared to do some heavy legal slugging. As long as the advertiser pays the bills, and isn't under some kind of court judgment, it's very hard for a magazine to turn down an ad. I know for a fact that the BYTE editorial people would prefer that certain advertisers would get mad and go away, so we wouldn't have to answer all the angry mail we get about the products.

Incidentally, I have never, *in the years I have written for BYTE, had any interference from the editorial staff regarding the opinions I express, regardless of whether I'm discussing a heavy advertiser or three lads and lassies working in a garage. The only suggestions I've ever been given have been "I think the readers might like to see more about" certain machines.*

Let me drive it home: "Advertised in BYTE" does not imply the approval of BYTE's editors, staff, or columnists.

Some principles: first, if something sounds too good to be true, it probably is. If it's not, independent reviewers will tell you soon enough. If you can't wait for the reviews, you may be lucky, but you may also be stung.

Second, there are distributors—certain stores, selected mail-order software houses, some systems consultants—with a reputation for honest dealing, including full refunds if the customer isn't satisfied. Those outfits simply cannot operate on the same markup as the heavy discounters do. If you plan to buy an unfamiliar product, or a product that's not known to work on your system, then you'd probably do better to pay a higher price and deal with someone you know. If you don't know who the good guys are, it's not too hard to find out; the word gets around.

I agree there's a problem; indeed, it's one reason I write this column. I like *these little machines, and I don't like to see anyone get stung. . . .* **Jerry**

Abnormal Warranty

Dear Jerry,

Those absurd software disclaimers that you detest can now be found on hardware: last week, I purchased a joystick for a video game. One model had "2-year warranty" in bold letters on the box. I chose that one. After I arrived home, I read the warranty and encountered one of the silliest and most meaningless disclaimers yet: "This warranty applies only if your joystick is used in a normal fashion, prescribed by the instructions for your video-game console. It is void if the joystick is abused, tampered with, used unreasonably, or fails as a result of normal wear."

If it doesn't cover failure "as a result of normal wear," what does it cover? First they say that the warranty applies only if the product is used in a "normal fashion," and then they disclaim that statement. I am beginning to appreciate Digital Research's disclaimers. At least they are unambiguous.

Robert Swirsky
412 Arbuckle Ave.
Cedarhurst, NY 11516

Alas, the age of chivalry is dead. We have entered the age of sophisters, calculators, economists, and lawyers, and the glory of America is extinguished. . . (with some apologies to Edmund Burke). . . . **Jerry**

No Insults Intended

Dear Jerry,

I have been reading your column for several years. I was extremely insulted by a comment in "Zenith Z-100, Epson QX-10, Software Licensing, and the Software Piracy Problem" (June, page 411): Snapshot's "easy to install: a 16-year-old did ours. . . ." I'm 16 years old and know my way through electronics and my Apple. There are many BYTE readers in my age group, and many of my friends are also computer nuts. Something is very wrong

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if the standard for ease of installation is whether a 16-year-old can do it. I built a digital music synthesizer and interfaced it to my Apple. You may say in your report of the West Coast Computer Faire (June, page 306) about the Hero robot that your kit-building days are long gone, but mine aren't.

Adam Dershowitz
2 Tudor City
New York, NY 10017

Without intending insult, may I suggest you're not an entirely representative 16-year-old? One must have a few milestones in making comparisons, lest we all flounder in a sea of relative concepts. In another place I mentioned that Osborne Starter-Pack could be used by Boy Scouts; surely no one believes I intended to insult the BSA? . . . **Jerry**

Dear Jerry,

I am embarassed for both you and Volition systems. Please do not refer to competent software engineers as "hackers" in print again. Had you not made it clear in the first paragraph of your article ("Ulterior Motives, Lobo, Buying Your First Computer, JRT Update," May, page 298) that you were using an unusual meaning for the word "hacker," I might have concluded that Volition sold untested, undocumented products.

There is a subtlety in the meaning of the term "hacker" that has not been properly communicated to you (for the definitive explanation of what a hacker is, I refer you to *Psychology of Computer Programming* by G. M. Weinberg). A hacker is not only talented; he is also undisciplined. He is addicted, not to the field of software development as a serious profession, but to the implementation of code (and coding is a surprisingly small part of professional software development).

The hacker makes programs that work; this does not mean he writes programs that are good. Two examples of the difference between working and good programs are: a good program is well documented (hackers don't document) and a good program has been tested and proved to work with all kinds of erroneous entries (hacker programs tend to fail catastrophically if you give them bad data).

To put it another way: if you want a pretty painting or a fast-paced video game, get an artist or a hacker. But if you want a solid bridge or a powerful Modula-2 compiler, get a mechanical engineer or a software engineer.

I've made my point, but let me give you an analogy in the realm of science fiction: suppose you were a not-yet-famous author, and a distinguished reviewer referred to you in a distinguished publication as an "amusing writer of sci-fi." This is roughly comparable to Volition being reviewed by Jerry Pournelle in BYTE as a "nice bunch of hackers."

Marc Stiegler
132 Laurel Way #2B
Herndon, VA 22070

Alas, despite your embarrassment, there is no universal agreement on what is meant by a computer "hacker." I assure you that very highly professional programmers often refer to themselves as hackers and do so with some pride. Weinberg's is but one of a number of attempts to define this elusive word.

Moreover, there may be times when what one wants is a hacker even in your sense of the word. A well-known and wealthy writer, having become enamored of my first computer (Ezekial, RIP), decided that he could do much better. He went off to get a contract for a book about using computers. With the advance, he engaged a firm of consulting engineers to build him a system. He gave them few-to-no financial restrictions, and at last count he not only didn't have a working computer, he was forced to use his typewriter to write his computer book. (Sometimes it may be better to have it Wednesday than perfect.) In any event, let me assure you that the troops at Volition are thoroughly professional, and I intended no insult to them.

Your final paragraph refers to Harlan Ellison's well-known campaign to extirpate the term "sci-fi." It's true that use of the phrase marks one as unfamiliar with the customs of organized science-fiction fandom, and indeed some writers do resent it; but most of us take it in stride. As for my tales, I hope they're found entertaining, although not all are intended to be amusing. . . . **Jerry**

CP/M vs. TRSDOS

Dear Jerry,

Some general thoughts on CP/M: I use the TRSDOS operating system that came with my Model II about two years ago. The first thing I noticed was the 'DIR' command—TRSDOS is much better. Another difference is its printer interface. CP/M could learn from the TRSDOS 'FORMS' command. You can still use the printer, but not as conveniently. If you forget to turn on the printer, CP/M hangs up. TRSDOS gives you the 'Printer Not Ready' prompt. For disk files, TRSDOS could find a file no matter what disk drive it was on; CP/M requires that you specify the drive in your command. Also, if you accidentally call out a disk drive with no disk in it, CP/M hangs up, requiring a reboot. TRSDOS simply tells you 'Disk Drive Not Ready.'

I have more to learn about CP/M, but from here, it does not stack up to TRSDOS. If there is any significant speed difference, if hasn't affected me yet. I don't see why Radio Shack doesn't capitalize on its excellent operating system and expand its available software.

Bruce M. Beatty
1218-B Tom Hunter Rd.
Charlotte, NC 28213

The fault, alas, is not in your CP/M but in your CBIOS. (Customized Basic Input/Output System is the software that tells CP/M what kind of computer it's working with.) We've had recovery from "Drive Not Ready" since we began using CP/M 1.4. For those with Z80 systems, there's also ZCPR, a replacement for the Command Processor in CP/M; this has the "search all disks for file" feature you like, plus a number of others. (ZCPR is public domain; there's a lot *of documentation. It's available from Workman and Associates, or through one or another of the CP/M user clubs.) Finally, there's CP/M Plus, which is just gaining popularity; it has many features the older CP/M didn't.*

The TRSDOS you see is greatly changed from the early versions which so exasperated TRS-80 Model I users. Even with fixes, there was never a version of TRSDOS that I preferred to CP/M, if for no other reason than that, for better or worse, CP/M became the de facto standard for the micro world and made for widespread distribution of programs—and thus heavy investment in program construction and documentation.

I'll even hazard the prediction that one or another form of CP/M (probably Concurrent CP/M-86) will continue to be the de facto standard as the micro world grows up. . . . **Jerry**

IBM's Keyboard Best

Dear Jerry,

There is one bit of critisism that I must share. I own an IBM Personal Computer, with the IBM keyboard. I like the IBM keyboard. It has great feel and is a pleasure to use. I realize that it is not a standard keyboard (what is a standard keyboard?), but the time necessary to use

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it is well worth the effort. I have yet to work with a keyboard that did not require some adaptation by the user (Televideo and DEC keyboards require a tremendous amount of user flexibility).

Scott Wentzka
9875 Northwest 16th St.
Coral Springs, FL 33065

You are not alone in defending the IBM PC keyboard. It's obvious that my dislike of the keyboard hasn't precisely ruined IBM's sales: I'm still waiting for the PC I ordered months ago!

I remain unrepentant, though: the IBM Selectric Typewriter was the *standard keyboard for most of the potential computer users in the world. True, those who never learned touch-typing can adjust to most anything, but why did IBM have to make things complicated for those of us who'd already learned the Selectric? Fortunately, it's now possible to reprogram the whole keyboard, so that one needs only a source of keytops to customize properly; the issue is rapidly becoming moot. . . .* **Jerry**

Bootstrap Solution

Dear Jerry,

This is in response to comments in your July User's Column about moving programs from one computer to another.

I am writing this on an Epson QX-10, which we have had for about three months. One reason we decided on the QX-10 was that, even if Valdocs did not work out, we would still have access to the great body of CP/M programs. Unfortunately, we found out that we were wrong because no other programs were available on Epson-format disks.

It is very little help to be able to transfer programs from machine to machine because I have no other CP/M machine, nor do I have CP/M programs. In fact, it is the CP/M programs I wish to obtain.

Of course, it is likely that I could find someone locally who also has a CP/M machine. If that person also has the standard 8-inch CP/M disks, I could send away for the CPMUG disks, then copy those programs to the Epson. If, however, the other person does not have the standard 8-inch CP/M disks, we are both back to where I started.

What is really needed is a way for a new CP/M user to access the various computerized bulletin-board systems (CBBS) that have CP/M software. Naturally, if the user had the MODEM7 program, access by modem would be fairly easy. Unfortunately, MODEM7 is itself a CP/M program, which the new CP/M user will not have.

Therefore, what is really needed is: a "bootstrap" program, a tiny program that is easily implemented on a bare-bones machine, which will download a full-blown CP/M loader program from a CBBS that uses the bootstrap protocol. The bootstrap itself should be made extremely simple for easiest implementation (it may be used once per system, then never used again). It should be described in multiple languages; BASIC would probably be easiest, although some CP/M systems may not have BASIC, so the bootstrap should also be available as an assembly-language listing. The bootstrap format could be quite slow, since it should allow BASIC implementation and it would only be used once.

The existence of such a program would not, of course, solve all of the problems involved in getting access to CP/M public-domain software. First-time users may have to be inducted into the mysteries of assembly language, but achieving a working program can be done without understanding, if the program has been fully developed and the process of entering the program is described explicitly. In addition, the various concepts of ports, modems, and RS-232C connections and cables would have to be addressed. Also, there would be the little matter of phone numbers for the appropriate CBBS. But this information can be transferred on paper, in a book or an article, and would allow new CP/M users access to public-domain software.

This approach could be more help to the new CP/M user than *The Transporter*.

Terry Ritter
2609 Choctaw Trail
Austin, TX 78745

The Transporter *(reviewed in July, page 323) was designed to solve the problem of getting the first program—such as MODEM7—across to new machines.*

A second problem involves ethics and good sense. A number of people have been kind enough to write some excellent CP/M programs and put them in the public domain—which is to say, to give them away. Having done that, they naturally feel little obligation to support the programs or transfer them to new machines and formats.

On the other hand, when someone does *take the trouble to improve program documentation and transfer public-domain programs to new formats, that person is sometimes attacked as a pirate or thief for charging for this service. Usually the attack comes from some outsider, but once in a while it will come from the original program author. This leaves little incentive for anyone to collect public-domain software, test it, and distribute it on new formats.*

Incidentally, much of what you describe already exists on one or another public computer bulletin-board system. Finding out which ones have what takes a fair amount of work, of course, and the connect time for transferring long files can be lengthy. As an example, ZCPR, the improved Z80 Command Processor for CP/M, takes up about 15 disks and many hours to transfer by telephone.

If anyone has—or wants to write—the programs you described, I'll be pleased to review them. In the meantime, I talked Barry Workman into putting up a number of his CP/M utilities into Epson QX-10 format so I could use them; he sells them at reasonable prices. Many, but not all, are public domain. . . . **Jerry**■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

BYTE's Bugs

Line Change

Dean Brown of Alderwood Manor, Washington, spotted a bug in James Folts's "Cross-Reference Utility for IBM PC BASIC Programs" (August, page 378). The program will work properly with programs having 5-digit line numbers if line 6050 is changed from

```
LABEL$(LABEL.NUMBER) = SPACE$(5)
```

to

```
LABEL$(LABEL.NUMBER) = SPACE$(6)
```

Brown explains, "This change is necessary because the STR$(val) function used in line 6060 prefixes positive numbers with a blank, thus requiring the field length to be one greater than the length of the line number to be displayed."■

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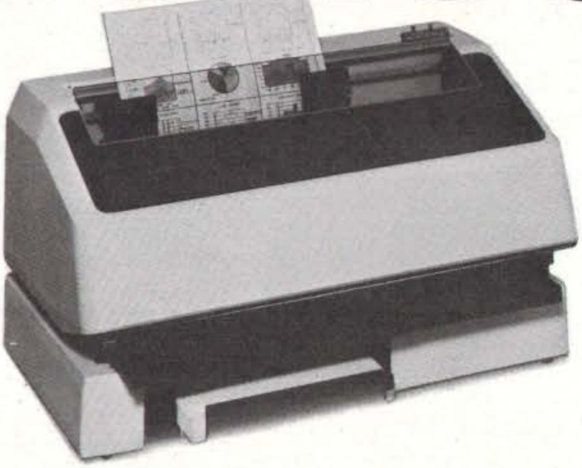

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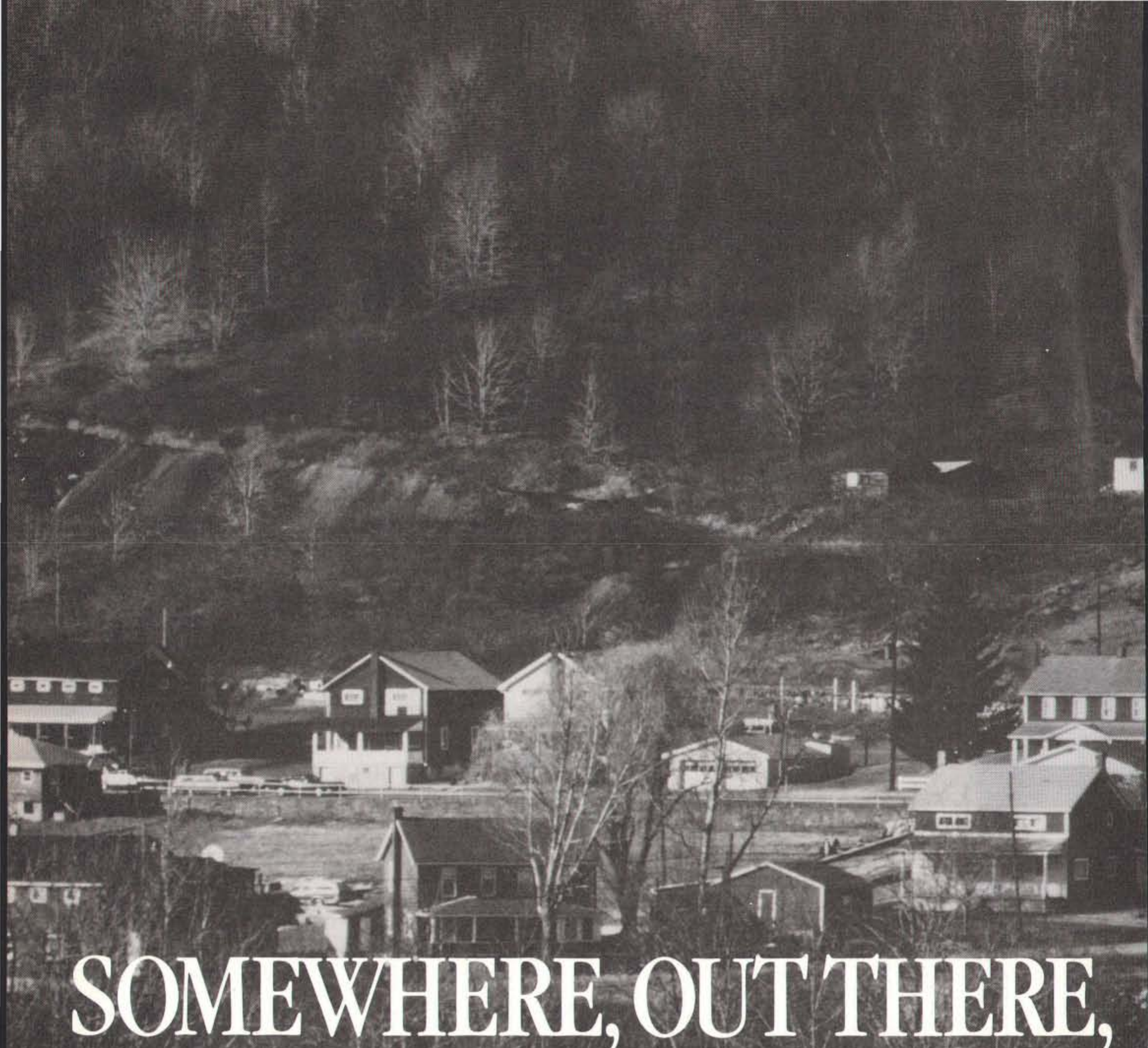

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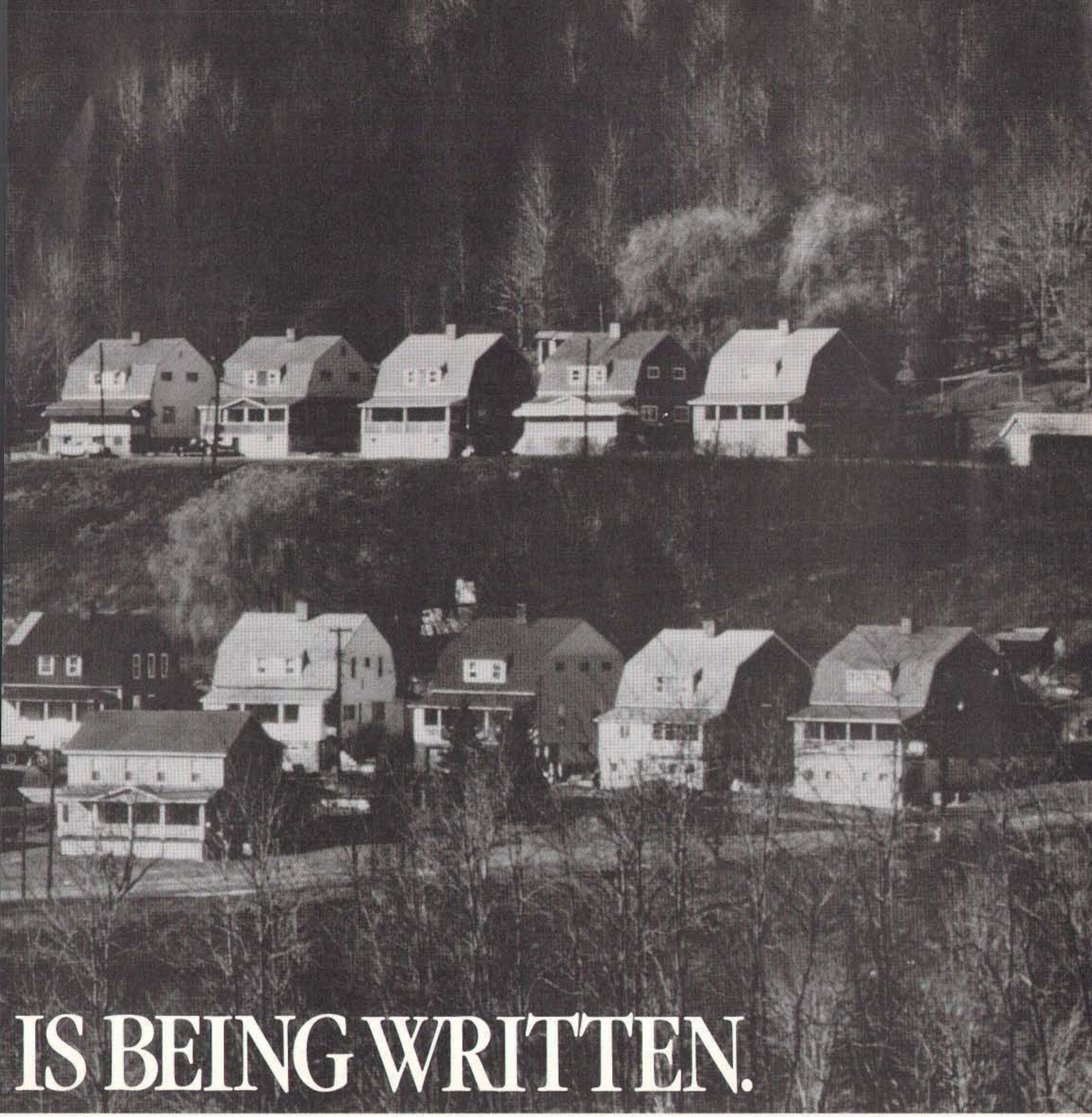

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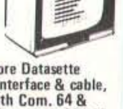

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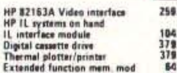

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The User Looks at Books

The best and the worst books on CP/M, Pascal, C, and Ada

by Jerry Pournelle

When I first got started using microcomputers, back in the dark ages of the 70s, there was a simple solution to the computer-book problem: you bought every book on microcomputers as soon as it was published. You wouldn't go bankrupt, even though the books were overpriced, because there weren't very many.

I used to include book reviews in the User's Column. Now there's no room, but we get a lot of letters asking for more book reviews. Meanwhile, four cubic feet of unreviewed books lie scattered on shelves throughout Chaos Manor. I've therefore struck a deal with BYTE: I'll do an occasional special roundup on books.

CP/M Books

The CP/M manuals put out by Digital Research are notoriously poor. This particularly upset my late mad friend. "First they translated them into Swahili," he said. "But what made me really mad was when they encrypted the translation." Digital has since made great strides toward reforming its document foundry; however, for many years the company simply couldn't produce a readable document. The result was a spate of books to teach you how to use CP/M.

One of the earliest of these was *The CP/M Handbook with MP/M* by Rodnay Zaks. It's still readable, and much better than the Digital manuals; Zaks's book can serve quite well as an introduction for beginners just learning to use the CP/M operating system. It spends rather too much time on ED, the nearly unusable text editor that comes free with CP/M, and rather too little time discussing the difference between logical and physical devices, but all in all it gets the basic job done.

Another good introduction that begins at a very low level is Thom Hogan's *Osborne CP/M User Guide.* Like the Zaks book, Hogan assumes the reader begins with no knowledge beyond the ability to turn the computer on. Both explain what disks are and the difference between disk storage and memory. I find that I prefer Hogan's organization and style to Zaks's, but I'm not sure which is best for beginners.

Alas, both of these books suffer from the same defect: they become more obscure just as they get interesting. For example, it's possible under CP/M to have your computer run a series of programs on startup. Zeke II, the machine I'm writing this on, goes through memory checks, displays disk directories, and formats the "memory disk," after which it calls in the text editor; all this happens automatically on reset. Both Zaks and Hogan tell you how to make your machines do that, but it sure would be difficult without another source of information. You can puzzle out how from their text, but you'll curse the author before you're done.

The Hogan book is more complete, and if you're willing to learn something about CP/M it will teach you more; the Zaks book is a better "cookbook" for just getting the job done.

If you're really interested in learning about CP/M, Jack D. Dennon's *CP/M Revealed* is your best bet after you've done the introductory work. Dennon's organization is rather poor. He begins with baby talk but quickly gives advanced material. For all that, his book is unique and invaluable for those willing to invest the time in understanding it. You'd do well to buy Hogan's book at the same time you get Dennon's, though; you'll need both.

CP/M Revealed assumes you want to know something about assembly-language programming, at least enough to be able to write and assemble simple programs. It thus starts you with simple programs, such as Hello, and quickly goes on from there. Before the book is done, you've been shown how to merge files, assemble them, do random-access file management, make BDOS (basic disk operating system) calls, and even recover erased files. These are all valuable exercises. However, you have to do the work; there's not much point in getting Dennon's book just to read. I sure wish someone would put out a disk with Dennon's programs already typed in, so that you merely need to assemble them.

Finally, there's Mark Dahmke's *Microcomputer Operating Systems.* This is an advanced book about small computers in general, rather than a book about CP/M. If you're interested in what's going on in your machine and why programmers tend to do things in certain ways, this book is enlightening. Like the Dennon book though, it's not required reading.

Whatever you get, though, get a copy of the *CP/M Diskguide* by Curtis Ingraham. This is one of a series of small-format handbooks put out by Osborne/McGraw-Hill, and it's an excellent ready reference. It won't teach you anything you didn't know, but that's not its purpose. What it does do is list just about every useful command CP/M recognizes. Along with the commands, the book gives a terse but accurate description of what each command does. I find I use it all the time, since I tend to forget the precise format for the various options you can give STAT and PIP, and I sure don't remember the memory map for my system. All that and more is in this useful little book.

Another very useful tool is *The User's Guide to CP/M Systems and Software,* and no, I didn't write it. Given the way people trademark things, I wouldn't be surprised to find someone trying to trademark "User"; fair warning, I got here first.

The *User's Guide* is somewhere between a magazine and a book. It looks like a magazine and is sold in issues, both in stores and by subscriptions, but the contents are more book-like. A great deal of the *User's Guide* is written by Tony Bove and Cheryl Rhodes; they have the knack of explaining CP/M programs very well indeed.

The *User's Guide* seems to have grown out of *Datacast,* which was a Jim Warren publication edited by Bove and Rhodes; it, too, had a lot of easy-to-understand instructions and shared their propensity for classical artwork on the covers.

A typical *User's Guide* contains articles on how to use Wordstar and Supercalc, overviews of particular implementations and installations of Wordstar, and a general article on CP/M. Naturally, each issue is different. So far I haven't found one that wasn't worth more than what it costs. Recommended.

Pascal Books

There are about a zillion books on Pascal. I can't possibly review them all, and I'm sure to leave out someone's favorite. Apologies in advance.

One book I do *not* recommend is David Heiserman's *Pascal,* published by Tab Books. If you have a TRS-80 with cassette and no disks, and through some misguided chance you've acquired Supersoft Tiny Pascal, the book may be useful; but if you don't, it isn't. I really cannot recommend that you spend much time with Tiny Pascal anyway, and systems without disk drives belong in the dark ages. Trying to learn a language using a cassette is a surefire way to get discouraged and give it up as a bad job.

Heiserman's book suffers from the generic problems of all Tab books: sloppy editing, tiny margins, unaesthetic print and layout, and all-around carelessness. As an example, he states:

```
WRITE('HELLO', 'THERE','.
HOW ARE YOU?');
```

with the expectation that it will print "HELLO THERE. HOW ARE YOU?" but of course it won't, for there is no space between HELLO and THERE. Trivial but infuriating slop like this seems characteristic of just about every Tab book I've seen.

Slightly better is Ronald Anderson's *From BASIC to Pascal,* but it, too, suffers from the Tab syndrome, and the examples are reproduced from a dot-matrix printer; they're very hard to read. The book purports to tell BASIC programmers how to switch over to Pascal, but I'd hate to have to rely on it as my guide.

Another book I don't recommend is Kenneth Bowles's *Microcomputing Problem Solving Using Pascal,* which is the standard textbook at UCSD—possibly because the professor who teaches Pascal is named Kenneth Bowles. I've attempted to read this book, and it's impossibly opaque. It's also done in typewriter script, making it physically as well as intellectually difficult to read.

Two more I can't say I care much for: Rodnay Zaks's *Introduction to Pascal* and *A Primer on Pascal* by Richard Conway, David Gries, and E. Carl Zimmerman. Zaks's book isn't all that bad, and it does go into some pretty complicated concepts before it's done; it is certainly more pleasant to read than the book by Conway et al. You could live with Zaks, and if there's nothing better conveniently at hand, you could learn the language from it; certainly I'd prefer it to the *Primer* or either of the Tab books. There are, however, better introductory texts.

The book I learned with is Peter Grogono's *Programming in Pascal.* It begins at elementary levels and goes into progressively more complex subjects. I very much like his Pascal style and program layout, and his discussion of records and event rings is the best I've seen in any book. It's not really a beginning text, but if you're familiar with programming in general, Grogono's book is very good for those who want to learn Pascal as an additional language. However, there's no mention of CP/M or microcomputers. Grogono can teach generic Pascal, but you'll still need a guide to your particular implementation.

Our current favorite beginner's text is *A First Course in Computer Programming Using Pascal* by Andrew M. Keller. This book isn't complete in that there's not an adequate discussion of records and pointers, but this book and Grogono's combined can teach you to write practical programs without too many tears. (On price alone, the Zaks book may be the way to go: one book instead of two. However, I don't think Zaks's is as good an introduction as Keller's, and isn't as complete on complex issues as Grogono.)

For Apple users there's Elliot B. Koffman's *Pascal—A Problem Solving Approach,* which is intended as a collegiate-level text and goes up to relatively complicated programs. Not as general as the Keller/Grogono combination, it is adequate for learning a lot about UCSD Pascal, and some may prefer Koffman's style. There are a lot of examples and problems, with answers in the back of the book. For reasons I don't understand, this book, like many Pascal textbooks, gives program examples all in uppercase. This encourages what is, in my judgment, bad programming style. I think programs are much more readable if uppercase is used for reserved words, such as BEGIN and END, and

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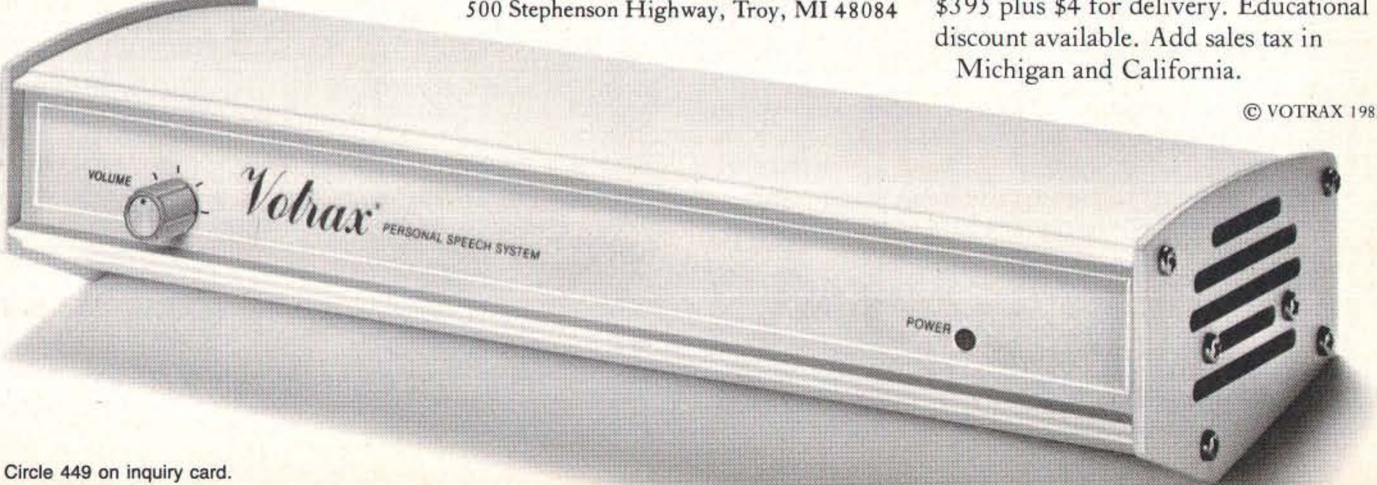

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most of the program is written in lowercase letters.

One book I've liked a lot was *Doing Business with Pascal* by Richard and Douglas Hergert. It's not a beginner's book, but it would do as a follow-up after Keller, and it offers a great number of practical business programs. Any small business owner faced with writing programs, or trying to understand programs written for the business, would do well to read this book. It's mostly for UCSD Pascal, but the authors admit there are other implementations. At least it's micro-oriented.

Another, perhaps even better, is *Pascal Programs for Business* by Tom Swan. This book has chapters on word processing as well as business subjects. There are a lot of interesting programs; I can't testify that they'll work, but they look good to me, and they're well structured. Kernighan and Plauger have repeatedly stated that one of the best ways to learn programming is to read well-designed programs; Swan offers that opportunity. Some are so interesting that I intend to key them in Real Soon Now.

The Osborne/McGraw-Hill people have translated their two books, *Practical BASIC Programs* and *Some Common BASIC Programs*, into Pascal and put them out as, unsurprisingly, *Practical Pascal Programs* and *Some Common Pascal Programs*. You cannot use them as simple cookbooks because, alas, Pascal implementations differ a lot on how they do input/output and file management. Different machines and implementations require nontrivial modifications of the programs given in the books, and if you don't know something about the Pascal implementation you're using, you'll never get these programs to run on your machine.

On the other hand, provided you know something of Pascal, there are some really practical programs in these books. When I needed a matrix inverter, I found it in *Common*, and I've used the Bayesian decision-analysis program from *Practical*. I warn you again, you need to know what you're doing; these books make little concession to readers not familiar with their subject matter; there's no explanation of what matrix inversion means, and darned little about Bayes's theory of inductive reasoning. However, if you do know what you're doing, having these programs as models can sure save you a lot of time.

Finally, there's *Software Tools in Pascal* by Brian W. Kernighan and P. J. Plauger. Their original *Software Tools* (FORTRAN and RATFOR) used to be required reading for anyone seriously studying software engineering. This is a translation of their classic work into Pascal.

Kernighan and Plauger present an amazing variety of programs, many of which "cascade," in that later programs call in earlier ones as subprograms. Their "software tools" have thus become famous. It isn't so much the programs themselves; there are now better programs to do the jobs, such as text editing, that those programs were supposed to accomplish. The value of the books and programs is in teaching, by example, just what structured programming is all about.

Alas, *Software Tools in Pascal* was written for Pascal implementations running on machines a good bit larger than any BYTE readers are likely to have at home. It takes a lot of translation to get the "tools" running on a microcomputer. Unless you actually experiment with the programs, though, a good bit of the value of the book is lost.

I found that out some time ago and set my son Alex to doing something about it. The result was his own book and program disk. Using Pascal/M from Sorcim and Pascal MT+ from Digital Research as the two implementations of choice, he translated the introductory building blocks of *Software Tools* so that they will now run on most microcomputers. The disk comes with considerable documentation, including the best exposition of what Pascal error messages

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mean and what is likely to have caused the error, that I have seen yet in any of these texts.

If you want to learn Pascal, you could do worse than make a package deal: MT+ Compiler; three books: Keller, Grogono, and the Kernighan and Plauger; and Alexander Pournelle's *A Primer on Pascal for CP/M Systems*.

C Language Books

There aren't so many books on the C language yet, but given time I'm sure there will be. A good way to find out if you will like C is to read the August 1983 issue of BYTE.

Not long ago, the only way to learn C was from Brian W. Kernighan and Dennis M. Ritchie, *The C Programming Language*. Now there are better introductory books, but Kernighan and Ritchie is still the standard, and since Kernighan was the principal author of the C language, he can speak with some authority when he writes about it.

The book is a bit terse. It definitely assumes you know something about computers and programming. It was also written under the assumption that you're working with a system using the Unix operating system. On the other hand, there's a good tutorial guide that is invaluable provided you can make the proper changes so that the tutorial programs can run under your particular implementation.

You can learn the C language without getting Kernighan and Ritchie, but that's doing it the hard way. You're also working too hard if you make it the *only* book on C that you buy.

Two better introductory books are Thomas Plum's *Learning to Program in C* and Jack Purdum's *C Programming Guide*. I'd rate Plum's book slightly better for beginners, but if you already know something about programming, Purdum's is more complete and often gives comparisons of how BASIC and C would handle the same problem. You don't need both.

Ada Books

Despite some disagreement from a few readers, I continue in my belief that learning Ada is the best long-term job insurance a programmer can have. Ada is, of course, the new language to be supported by the Department of Defense (DOD). It's full of bells and whistles and special features; its major strength is that, like Modula II, it is designed to allow co-processing, which is to say, to let computers do more than one part of a task at the same time.

There's a very good history of Ada in *Software Engineering with Ada* by Grady Booch. This is, at first, an infuriating book; it addresses important questions, such as the crisis in software, in terms that I had a negative response to. If that happens to you, ignore it, and read on. Booch has a lot to say, and it's important. Indeed, as his book title indicates, the book is as much about software engineering, and a philosophy of software design, as it is about the Ada language. Part of the book is really heavy slogging; I found myself reading some pages more than once. Like me, Booch has strong opinions, and I guarantee he'll irritate some readers.

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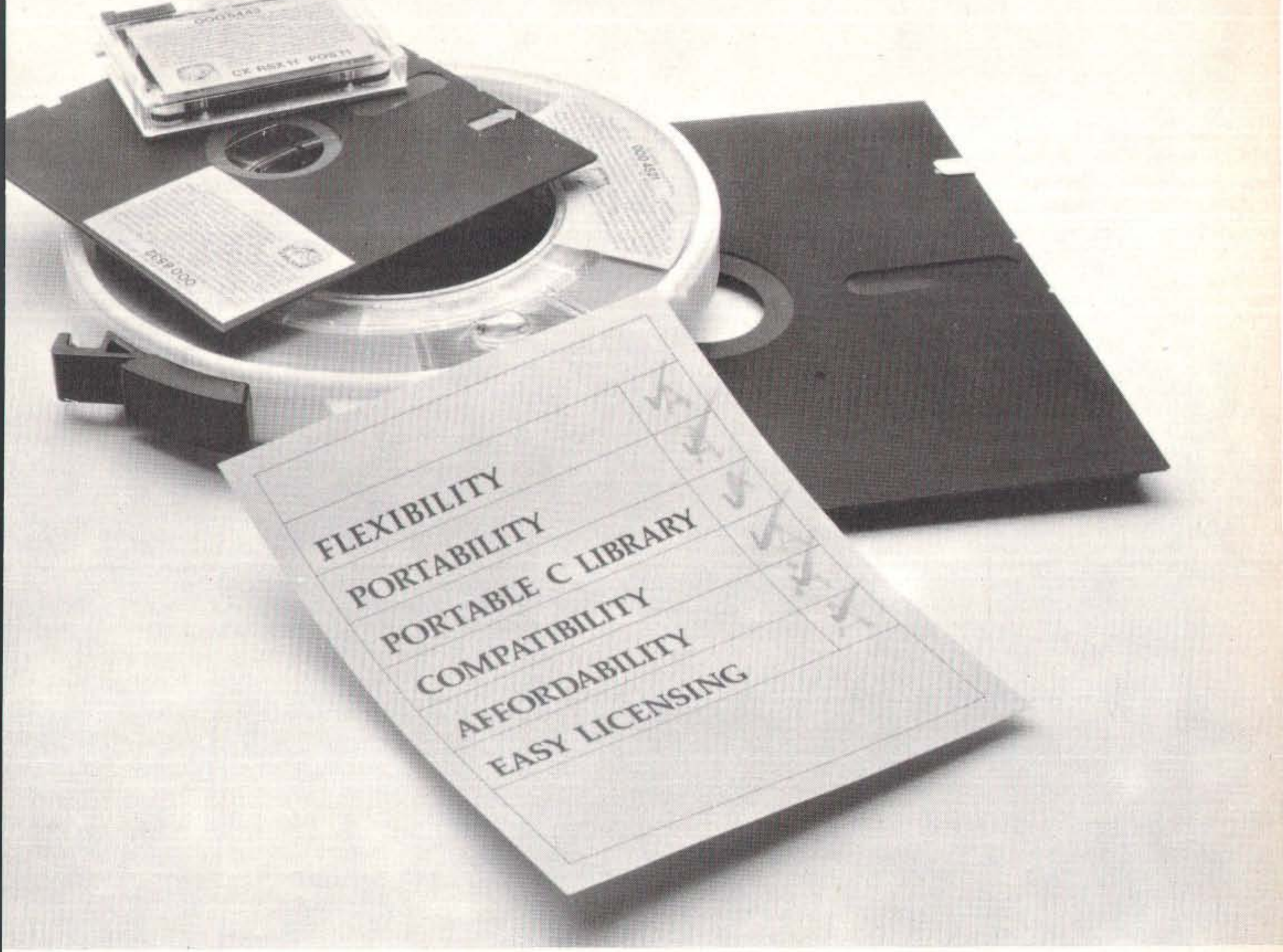

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No matter: it's worth the effort.

I have no opinion on the worth of the book as an Ada handbook, because I don't know enough about the language. Booch is an Ada enthusiast and presents an awful lot about the language; I think I could write an Ada program using Booch as my only reference, although I'm glad I don't have to. The real value, though, is in explaining why Ada does things in the way it does. I have no hesitation in recommending this book to anyone seriously interested in understanding Ada.

If you know how to program and just want to learn Ada, I can recommend *Ada—An Advanced Introduction* by Narain Gehani. This is a much more traditional book than Booch's. It doesn't go into the Ada "philosophy" much, but it has many more examples of Ada programs and how to write them. If I were required to write an Ada program quickly, I'd far prefer Gehani to Booch. On the other hand, if I were serious about learning Ada, I'd get both. Recommended.

The Ada Programming Language, by I. C. Pyle, used to be the only Ada book; alas, that was about all it had going for it. The book is dense, convoluted in style, and printed in a less-than-pleasing typeface. It also contains erroneous examples. In Pyle's defense, at the time he wrote the book there was no Ada compiler for him to work with, and the DOD publications he had to use as sources were only slightly more comprehensible than Linear B. In any event, it is a book whose time has passed.

The Tidal Wave

There's no shortage of computer books now. My publishing friends tell me computer books are the most popular nonfiction line in the industry. They also say the *real* tidal wave will arrive in 1984.

At best, there's ample information; the challenge will be to sort the gold from the dross. I'll try to do that in future reviews.■

Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.

Books Reviewed

Anderson, Ronald W. *From BASIC to Pascal* (Blue Ridge Summit, PA: Tab Books, 1982).

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Zaks, Rodnay. *Introduction to Pascal (Including UCSD Pascal)* (Berkeley, CA: Sybex, 1981).

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Software Received

Apple

Apple Cider Spider, an arcade-type game. As a spider, you must get back to your web in the rafters of the apple cider factory. Avoid rolling apples, slicers, crushers, bottlers, and cappers. With luck and timing, you can race the clock to make it home. For II, II Plus, and IIe; floppy disk, $34.95. Sierra On-Line Inc., Sierra On-Line Building, Coarsegold, CA 93614.

The Apple Family Singalong Christmas Disk, a disk of Christmas carols. This multivoice, four-part harmony of 16 Christmas carols is complete with words and lasts one-half hour. Handy for Christmas parties, office parties, or family gatherings. For II, II Plus, and III; floppy disk, $24.50. Solutions Softworks, PO Drawer 72289, Roselle, IL 60172.

Bermuda Race, a sailing simulation of the blue-water race from Newport, Rhode Island, to Bermuda. One or two players can chart progress as you sail 635 miles of the open Atlantic. Race against those who set the Bermuda Race record with the help of nautical interactive tutorials. For the II; floppy disk, $29.95. Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46268.

Compiled Customer/Client Processor, a tailored database program designed to provide storage and manipulation of essential information concerning firms and individuals you do business with. Five of the 14 information fields are user defined. This program can search for records using five user-specified criteria, and it can print records and mailing labels. For the II Plus; floppy disk, $59.95. Proflo Software, POB 7115, Murray, UT 84107.

The DT Hunting Trainer/Simulator, a hunting-simulation program designed to accurately depict field conditions and bullet trajectories. Sharpen your hunting skills and judgment by taking into account wind, slope, range, target, and your own ability. For II Plus and IIe; floppy disk, $29.50. Datatech Software Systems Inc., 19312 East Eldorado Dr., Aurora, CO 80013.

The Einstein Compiler, a BASIC compiler that automatically translates Applesoft BASIC programs into Apple machine language. Compiled programs execute several times faster than uncompiled code and the compiler enables the integrated compilation and execution of multimodule programs. It provides debugging tools and offers mechanisms for program security. For II Plus and IIe; floppy disk, $129. The Einstein Corp., 11340 West Olympic Blvd., Los Angeles, CA 90064.

Gruds In Space, an illustrated adventure game in which you must deliver a rare fuel to a ship stranded on Pluto. You will be teleporting to other planets to solve many puzzles. If you can deliver the fuel on time, you win one million dollars from President Fred. For II, II Plus, and IIe; floppy disk, $39.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Homework Helper, Elementary Mathematics, an educational program that shows you the answers to mathematics problems and displays the extras you need to 'show your work.' Addition shows carries; subtraction shows borrows; multiplication shows intermediate products; and division shows long-division results up to the first three digits. For II Plus and IIe; floppy disk, $24.95. Colorado Cyphernetics Inc., 3550 Arapahoe #4, Boulder, CO 80302.

The Last Diary, a personal scheduling program. This record-keeping system is similar to the book form with a page for every day. Each day contains three comment lines. You can manipulate data for taxes or sales; print a day, week, month, or year; or search to find any string or character. For II Plus and IIe; floppy disk, $49.95. Proflo Software (see address above).

Memory Jogger, a perpetual-reminder program. Never forget another birthday, bill, engagement, or project deadline. This program serves as a flexible appointment-and-event calendar and time-management system. Features include one-time entry for recurring events, rapid search over all fields, and events listed chronologically or alphabetically. For II Plus and IIe; floppy disk, $29.95. Craftsbury Software Inc., 1623 Montague St. NW, Washington, DC 20011.

Monte Carlo Simulations, a general-purpose statistical simulation and analysis tool that contains two processes: a statistical-analysis process to match a set of raw data to a standard probability distribution, and the simulation process that generates random numbers based on an assumed probability distribution. For the II; floppy disk, $60. Actuarial Micro Software, 3915 A Valley Court, Winston-Salem, NC 27106.

Natural Family Planning Personal Charting Program, a fertility-charting program. Daily charts display each cycle with temperature and pH signs plotted in graphs as well as text. A statistical analysis of charted cycles displays cycle length, peak day, and the post-ovulatory phase. For the II; floppy disk, $39.50. Family Life Software, 1401 South 11th Ave., St. Cloud, MN 56301.

Pen-Pal, a word-processing program that uses your computer's full capabilities to type, edit, store, and print large amounts of information. You can write a letter with a few commands or produce a thesis complete with tables. For II and IIe; floppy disk, $59.95. Howard W. Sams & Co. (see address above).

The Quest, an adventure game. As King Galt's newest advisor, you must accompany his champion fighter, Gorn, on a quest to rid the kingdom of a vengeful dragon. Refresh your water supply and refer to your map of more than 200 locations in high-resolution graphics. For the II; floppy disk, $19.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Ramdisk IIe, a utility program for Apple IIe computers with extended 80-column cards. It has 25 screens of menu-driven documentation and supports double high-resolution graphics. Ramdisk IIe can be modified and copied. For the IIe; floppy disk, $19.95. Precision Software, 6514 North Fresno St., Milwaukee, WI 53224.

Sammy Lightfoot, an arcade-type game. This little acrobat with a fancy hairdo craves the spotlight under the Big

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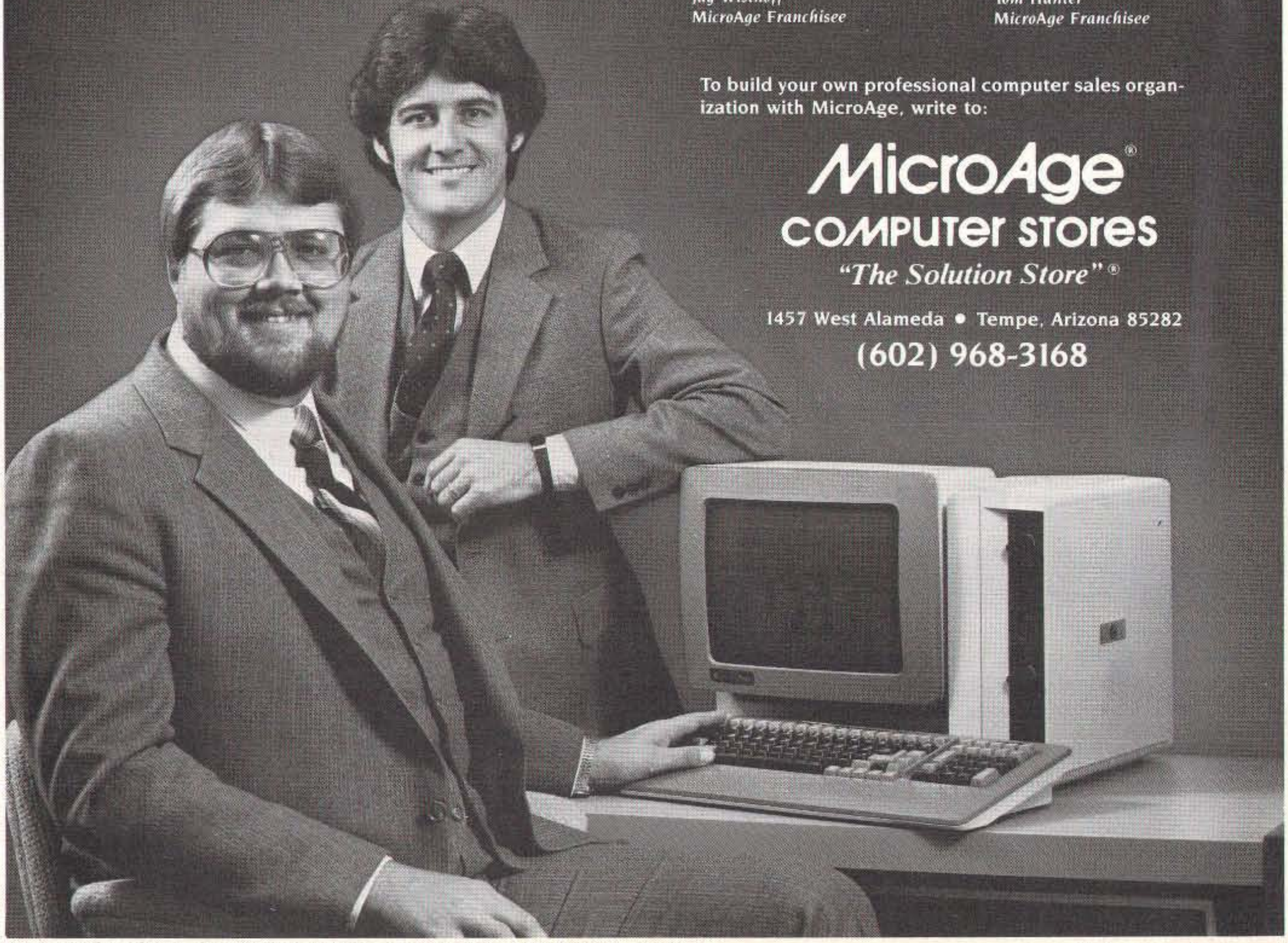

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Speedstat 2, a statistical-analysis program that provides an easy means for getting edited or raw data in and out of the system in the form of printed statistical reports or reusable data. For the II; floppy disk, $299. Softcorp International, 229 Huber Village Blvd., Westerville, OH 43081.

Stellar 7, a strategy arcade-type game in which you are in command of the Agrav Unit, Raven. You must reach the Arcturan star system and destroy the Supreme Overlord of the Empire, the infamous Gir Draxon. If you survive the onslaught of Arcturan forces on seven star systems, a Warplink will appear and transport you to the next star system. For II, II Plus, and IIe; floppy disk, $34.95. Software Entertainment Co., 537 Willamette St., Eugene, OR 97401.

Wine Connoisseur, a cellar-inventory program that also files your tasting notes on flavors, aromas, vintages, and regions. This program enables you to pick the appropriate wines for meals using screen prompts and multifield search. For II Plus and IIe; floppy disk, $39.95. Craftsbury Software Inc. (see address above).

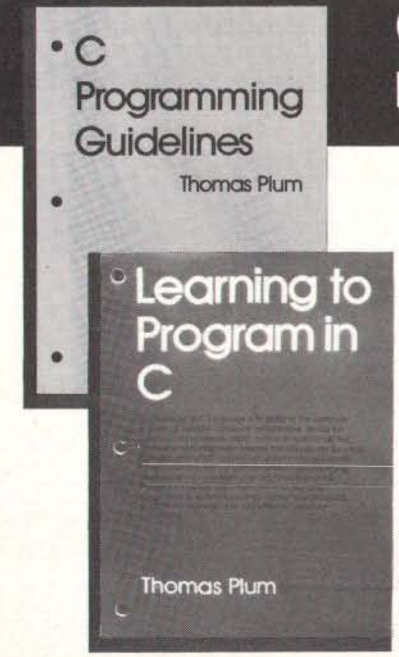
Wings Out of Shadow, an arcade-type game based on a science-fiction story by Fred Saberhagen. You command a spaceship that must fight four levels of a fleet of Berserkers: Bridge Game, Maze Game, Flight Deck, and Last Battle in which you must eliminate all Berserkers or distract them until the *Hope* escapes. For the II Plus; floppy disk, $34.95. Jim Baen Inc., 8 West 36th St., New York, NY 10018.

The Witness, an interactive-whodunit game. As a chief police detective during the 1930s, you must solve your toughest case to date: a sordid family affair that could put everyone from the heiress to the butler in jail. See if you can untangle the knot of motives and alibis and solve the case in less than 12 hours. For the II; floppy disk, $49.95. Infocom Inc., 55 Wheeler St., Cambridge, MA 02138.

Zaxxon, an air-battle simulation game. As the pilot of a fighter spacecraft, you must destroy a deadly armored robot by skillfully maneuvering to attack enemy installations and fuel tanks. Avoid the enemy's barrage of missiles and gunfire as you scale walls and navigate through force fields in the three-dimensional battlefield. For II, II Plus, and IIe; floppy disk, $39.95. Datasoft Inc., 9421 Winnetka Ave., Chatsworth, CA 91311-9969.

Atari

Astro Chase, an arcade-type game. As an ace space soldier you must save Earth from destruction by eliminating mines that threaten humanity. Avoid attacks from a variety of enemy fighters trying to distract you. For 400/800 and 1200; cartridge,



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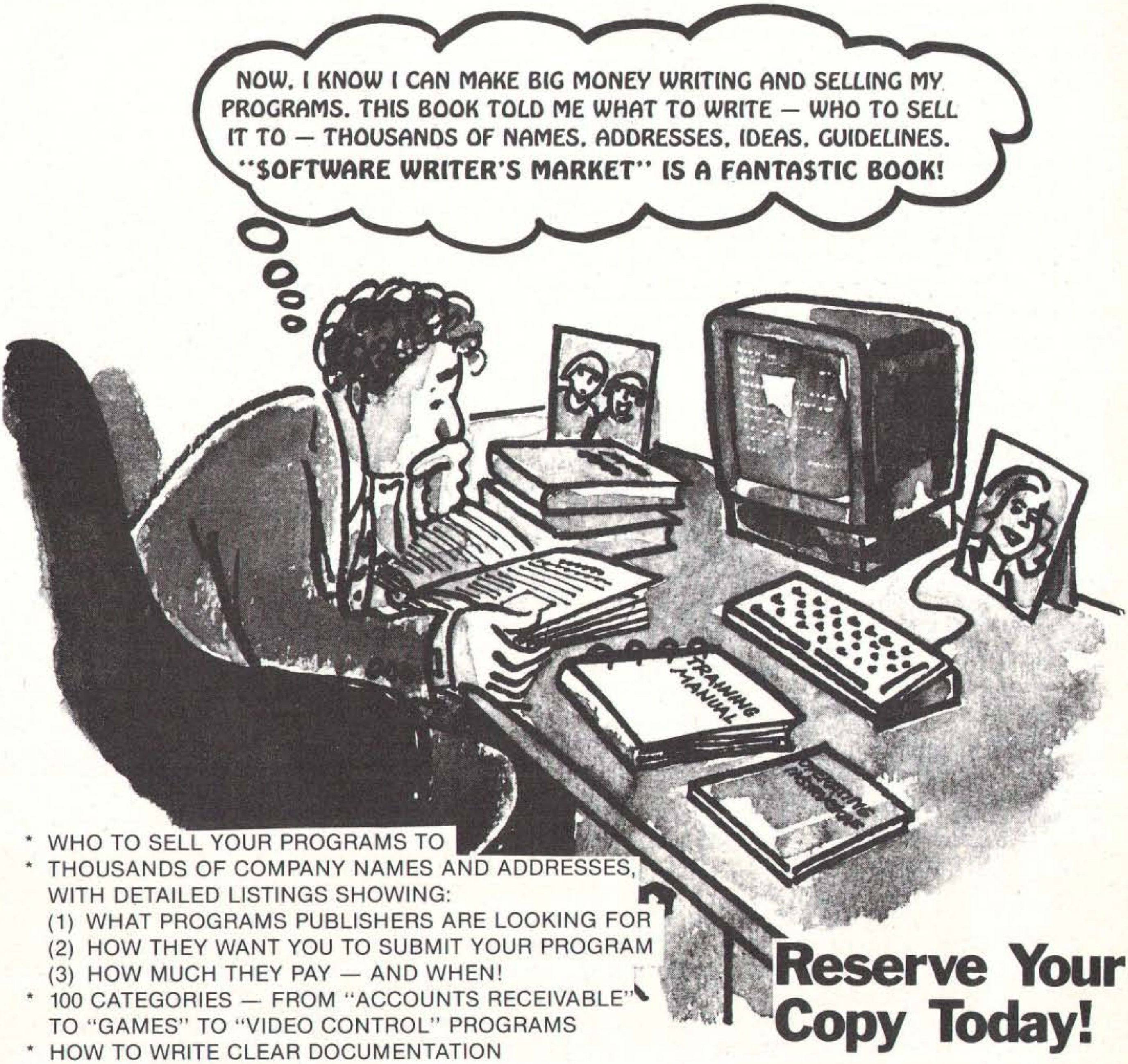
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Software Received

$40. Parker Brothers, 50 Dunham Rd., Beverly, MA 01915.

Beneath Apple Manor, a fantasy game simulation. You play the role of an adventurer, exploring a multilevel underground maze of corridors, rooms, and secret passages to kill monsters and find treasures. Increase your skills in each level with colorful high-resolution graphics. For the 800; floppy disk, $29.95. Quality Software, Suite 105, 6660 Reseda Blvd., Reseda, CA 91335.

DOS-MOD, a modification and enhancement program. Atari DOS 2.0S now includes full use of the screen, one-line commands, command-file capability, options to control wild-card file operations, and a reliable memory/disk swapping facility. For the 400/800; floppy disk, $35. Eclipse, 1058 Marigold Court, Sunnyvale, CA 94086.

Excalibur, a medieval simulation game. Based on the legend of King Arthur, you must govern a nation wisely using economics, diplomacy, magic, military strategy, even the loyalties of friends and enemies. An Atari joystick controller is required. For the 400/800; floppy disk, $29.95. Atari Program Exchange, 1265 Borregas Ave., POB 427, Sunnyvale, CA 94086.

Fathom, a subterranean rescue-mission game. You must locate three pieces of Neptune's trident to free his mermaid daughter from her underwater prison. You can switch from a dolphin form to a seagull to search both sea and sky for the missing pieces. Learn to make magical stars and starfish to help you in your mission. For the 2600; cartridge, $29.95. Imagic, 981 University Ave., Los Gatos, CA 95030.

Kaboom, an arcade-type game. You are after the Mad Bomber, a scowling convict who roams the rooftops dropping bombs with lighted fuses. As you maneuver water buckets to try to catch the falling bombs, you are accompanied by the music of the 1812 Overture. For 400/800 and 1200; cartridge, $34.95. Activision Inc., 2350 Bayshore Frontage Rd., Mountain View, CA 94043.

Moon Shuttle, an arcade-type game. As the pilot of a Moon Shuttle flight, you repeatedly encounter unexpected dangers as you blast your way through asteroids and bomb launchers while the enemy skillfully dodges your sights. For 400/800 and 1200; floppy disk and cassette, $29.95. Datasoft Inc., 9421 Winnetka Ave., Chatsworth, CA 91311-9969.

Moonsweeper, an arcade-type adventure. You must reach and rescue miners stranded on hostile moons in an outerspace quadrant. Avoid a deadly photon torch, space bullet showers, and Aurora flare activity at lethal levels. Land on as many moons as you can while you rescue the miners. For the 2600; cartridge, $30. Imagic (see address above).

Murder on the Zinderneuf, an adventure mystery game in which you pick one of eight detectives and try to solve the mystery of the Zinderneuf blimp before it lands. If you fail, someone will get away with murder. The mystery changes with each different detective. For 400/800 and 1200; floppy disk, $40. Electronic Arts, 2755 Campus Dr., San Mateo, CA 94403.

The Official Frogger, an arcade-game adaptation. You are a frog with seven lives who must get home safely.

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Operation Whirlwind, a WWII strategy game. You command a reinforced infantry battalion. Your job is to infiltrate enemy lines, destroying any resistance you encounter. The computer's forces harass you as you try to seize the city and hold it against counterattack in a limited amount of time. For 400/800 and 1200; floppy disk, $39.95. Broderbund Software Inc., 1938 Fourth St., San Rafael, CA 94901.

Orc Attack, a medieval-battle game. Save the castle from an Orc attack by hurling rocks and boiling oil from the parapet. Watch out for the sorcerer that is lurking in the background waiting to cast evil spells. For 400/800 and 1200; cartridge, $39.95. Thorn Emi Home Video, 1370 Avenue of the Americas, New York, NY 10019.

O'Riley's Mine, an underground adventure game. As Timothy O'Riley, you must travel down through your mine to capture buried treasures and return home safely to the top of the mine shaft. Avoid hungry river monsters and drowning in the rushing water. Use your dynamite carefully to destroy the monsters without destroying yourself. For 400/800 and 1200; floppy disk and cassette, $29.95. Datasoft Inc. (see address above).

Q Bert, an arcade-type game in which you hop Q Bert down a pyramid of cubes that change color with each successful landing. All the cubes must be changed to the same color before the player can move on to the next, more hectic round of play. For 400/800 and 1200; cartridge, $40. Parker Brothers (see address above).

Rabbit Transit, a fast-action arcade-type game. As a rabbit, you must get through the mysterious meadow and the land of ledges before you can start a family. Avoid meadow meanies who try to prevent you from reaching the turtle that will carry you down the river. For the 2600; cassette, $18. Starpath Corp. (see address above).

Super Cobra, a high-altitude arcade-type game where realistic missiles explode around you. The enemy base can be reached only by helicopter and the pilot must execute hairpin aerial maneuvers through a constantly changing terrain of mazes, caves, and cities with tall buildings, while under attack by missiles, meteors, tanks, and flying saucers. For the 400/800; cartridge, $40. Parker Brothers (see address above).

Wavy Navy, an arcade-type game. You pilot a PT boat being tossed by 30-foot waves while surrounded by enemy bombers and kamikaze fighters that appear on the horizon backed up by helicopters with blazing machine guns. For 400/800 and 1200; floppy disk, $34.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

The Witness, an interactive-whodunit game (see description under Apple). Infocom Inc., 55 Wheeler St., Cambridge, MA 02138.

Worms, a two-dimensional grid game. You are in control of electronic-light lines that geometrically resemble worms. They capture territories by laying trails from dot to dot. You can choose from five worms with varying capacities. For the 400/800 and 1200; floppy disk, $35. Electronic Arts (see address above).

XBASIC, a machine-language program to expand the power of Atari BASIC by adding 30 new functions that include string arrays, multicolor characters, player-missile graphics, and more. For the 400/800; floppy disk, $29.95. Superware, 2028 Kingshouse Rd., Silver Spring, MD 20904.

CP/M

ACPs, a series of Access Control Programs that interfaces with CP/M 2.2, reserving system-access for authorized users. Access to a system's resources (data and program files, peripheral equipment) is also user-specific. Handles log-on/off from multiple direct-cabled and dial-up terminals and includes a manual. Floppy disk, $150. Grover Software, POB 34216, Bethesda, MD 20817.

The Champion, a complete CP/M 2.2 accounting package written in dBASE II that includes general ledger and financial statements, accounts payable and purchase order, inventory, payroll, and accounts receivable with order entry and point of sale. This program eliminates the need for batching or sorting data and features a help function and automatic recovery in the event of a crash. Floppy disk, $195. Data Base Research Corp., Suite 155, 66 South Van Gordon St., Lakewood, CO 80228.

Grafprn, a utility program that lets you print high-resolution graphics files on dot-matrix printers. It calculates all the dots on the line between the endpoints and passes this information to the printer (rasterization). This program is limited to Tektronix Plot 10 graphics information. Floppy disk, $29.95. Micromaster Computer Consultants, 20877 Southwest Winema Dr., Tualatin, OR 97062.

Home Word Processing Service, a start-up kit. This program shows you how to start up a small word-processing service. It includes sample marketing, operating, and start-up plans, a manual, and a collection of pamphlets on such topics as legalities. Floppy disk, $29.95. South Bay Word Processing, Suite 290, 1558 Oro Vista Rd., San Diego, CA 92154.

Starburst, a systems-building and database management tool for the nonprogrammer that unites Micropro programs or links other software programs to perform ordinary office tasks. This program lets you build and create the menus you need. Floppy disk, $195. Micropro International Corp., 33 San Pablo Ave., San Rafael, CA 94903.

Commodore

Arcadia Mania, a fast-action arcade-type game in which you shoot nineteen waves of menacing aliens that are all out to get you. Try to kill as many as possible with your limited supply of ammunition. The more you hit, the higher your score. For the 64; floppy disk, $24.95. Perseus Programming, 9311 Avery Rd., Broadview Heights, OH 44147.

David's Midnight Magic, a fast-action electronic-pinball game. See how high your

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score goes using dual-flipper controls, bumper action, rollovers, and multiple-ball play, accompanied by all the sounds and lights of the classic arcade-pinball machine. Jostle the machine too much, though, and the game will tilt. For the 64; floppy disk, $34.95. Broderbund Software Inc., 1938 Fourth St., San Rafael, CA 94901.

Disk Duplicator, a machine-language program that provides a fast and convenient way to back up disks in as few as four exchanges. This system copies all programs, sequential files, user files, relative files, and more. For the 64; floppy disk, $14.95. H & H Enterprises, 5056 North 41st St., Milwaukee, WI 53209.

Disk Retriever, a machine-language program that provides a method to recover accidentally scratched programs and data files. This system can restore all programs, sequential files, user files, and relative files to their original status, provided that no prior information has been saved on that disk. For the 64; floppy disk, $9.95. H & H Enterprises (see address above).

Fourth Encounter, an arcade-type game. Hostile aliens are determined to overrun your planet and enslave the inhabitants. As waves of aliens swoop from the sky attacking you, you shoot lethal laser bolts to eliminate them. For the VIC-20; cartridge, $39.95. Thorn Emi Home Video, 1370 Avenue of the Americas, New York, NY 10019.

Jumpman, a multilevel arcade-type game. You are trained as the government's top-secret bomb defuser. With seven lives, you maneuver your way around obstacles to save Jupiter, which has been sabotaged with bombs throughout its thirty levels. You must defuse the bombs and restore the communications systems. For the 64; floppy disk, $39.95. Epyx/Automated Simulations, 1043 Kiel Court, Sunnyvale, CA 94086.

Typetest, a typing-speed testing program. Select how many words you'd like in your test and the program randomly selects that amount of words, lets you type them, and tells you how fast you typed them. For the 64; cassette, $11.95. Scott LeDoux, 67 Bridle Rd., POB 383, Billerica, MA 01821.

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Beneath Apple Manor, a fantasy game simulation (see description under Atari). Floppy disk, $29.95. Quality Software, Suite 105, 6660 Reseda Blvd., Reseda, CA 91335.

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Software Corp., Suite 210, 3685 Mt. Diablo Blvd., Lafayette, CA 94549.

Chip Wars, an interactive barnyard game for all ages. The chickens have flown the coop and are laying eggs all over the cow pasture. Farmer Dave must race against time to get all those chickens and eggs back to the henhouse while avoiding a prize-winning bull. Floppy disk, $29.95. Accupipe Corp., 222 West Lancaster Ave., Paoli, PA 19301.

Happy Alligator, an alphabet-teaching program designed for 3- to 6-year-old children. When the child enters the correct letter on the keyboard, the program draws a fun picture on the color monitor. Adult supervision needed only to change disks. Floppy disk, $29.95. Happy Alligator Co., 274 Cabot Court, Fishkill, NY 12524.

Instat, a general-purpose instant-statistics program. Features include complex contingency tables, histograms, means and standard deviations, and regression and comparison of means. Because P-values are computed automatically, looking up in tables is not required. Produces output on any printer. Floppy disk, $85. Statistical Consulting Services, 517 East Lodge Dr., Tempe, AZ 85283.

J-Bird, an arcade-type game. You are the J-Bird who must change the color of your world composed of a three-dimensional pyramid of colored cubes. You change cubes' colors by hopping onto a cube and marking it as your territory. Avoid the cartoon critters, a sly snake, a crafty cat, and Hob and Nob, two pesty characters who change your cubes back to the original color. Floppy disk, $36.95. Orion Software, POB 2488, Auburn, AL 36831.

Know Your Client, a utility program that lets you keep track of information about your clients. You can enter and instantly recall information such as employees in a company that you plan to visit, when to follow up calls, find clients who have common factors, print labels, and more. Floppy disk, $92.95. Execuware, Suite 300, 7415 Pineville-Matthews Rd., Box 10, Charlotte, NC 28226.

Meteor Math II, an educational math-adventure game. The pilot must destroy meteors to prevent Earth's destruction by solving math problems. Select the math mode (addition, subtraction, multiplication, division) and other options on a preflight checklist. Floppy disk, $44.95. Brauer Computer Support, Education Division, POB 86634, San Diego, CA 92138.

Oil Barons, a strategy game for one to eight players. You become a Texas Wildcatter and must amass more wealth than other players. A colorful game board helps players map and analyze land holdings. The computer keeps score and handles the banking, freeing players for optimal strategies. Floppy disk, $53.33. Epyx/Automated Simulations, 1043 Kiel Court, Sunnyvale, CA 94086.

Realfast 1, a utility program that links compiled IBM FORTRAN code to the high-speed mathematics of the 8087 Numerical Data Pro-

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cessor. It accelerates formatted input/outputs and mathematical operations. Floppy disk, $120. Geostat Systems International Inc., POB 1193, Golden, CO 80402.

Styx, an arcade-type game. The bewitching Styx is holding a vast expanse of your playing field. You must venture into its territory to stake your claim. Your stronghold grows as you force the retreating Styx into the corner. Floppy disk, $39.95. Windmill Software Inc., 2209 Leominster Dr., Burlington, Ontario L7P 3W8, Canada.

Venture, a financial-planning and analysis system. Financial analysts, strategic planners, capital budget analysts, and others in business can use this program to model, analyze, evaluate, and report on a business from an operational point of view. Floppy disk, $495. Weiss Associates Inc., 127 Michael Dr., Red Bank, NJ 07701.

TRS-80

Multiple Access Program (MAP), a utility program. You can search large data or text files in seconds. Enter information in any format you choose: words, phrases, sentences, paragraphs, or fixed fields and MAP will index every item three or more characters long. For Models II and III; floppy disk, $195. Softshell, POB 18522, Baltimore, MD 21237.

Psiconn, a strategy and concentration game. Try to take over the 600 positions of the board while skipping a barrier that will appear after every 10 positions. When you take one of seven bonuses, a barrier disappears. For the Color Computer; cassette, $23.95. The Software Factory, 7014 Southwest 46th St., Miami, FL 33155.

Rainbow's Corner, a collection of five learning games and two math utilities. Enliven a child's imagination and expand creativity by letting them hunt for a pot of gold in a deserted castle, decode messages at the control panel of an alien space ship, or pilot a Blue Mite. For the Color Computer; cassette, $19.95. John Boeschen & Co., 2901 Mirante, Richmond, CA 94803.

Texas Instruments

Cosmic Cruise, an arcade-type game. Travel through space while avoiding planets, asteroids, and attacking aliens. Capture rebel outposts to refuel and rearm. Your saucer's console warns you of impending danger. For the 99/4A; cassette, $11.95. JW Software, 814 West Main, Urbana, IL 61801.

The Dow-4 Gazelle Instrument Flight Simulator, a flying simulation of a private, four-seater, single-engine, instrument-equipped airplane. Beginners learn to take off, land, and use the radio; seasoned pilots refresh skills such as stall recovery and steep turns. In this game, if you crash you are rescued. For the 99/4A; cassette, $30. John Dow, 6360 Caton, Pittsburgh, PA 15217.

Run the Rapids, an arcade-type game. Navigate your raft through winding, whitewater river. Avoid protruding rocks, dangerous fish, and drifting logs. Pick up floating treasures to score points. For

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the 99/4A; cassette, $11.95. JW Software (see address above).

ZX81/T/S 1000

Lab-rat, a maze game. Find your way through a mind-boggling maze with only a compass and radar to guide you. As you proceed through the maze in as few moves as possible, your current position will be displayed in three-dimensional perspective. Cassette, $7.50. Event Horizon Software, 2345 Northfield, Trenton, MI 48183.

Master-Minds, a scientific-deduction game. You must break a 4-digit secret code in less than 15 attempts in order to win. Your computer responds with a few cryptic clues. Cassette, $7.50. Event Horizon Software (see address above).

Stor-a-lot, an address-file and mailing-list system. This program, which stores 90 addresses, has full editing, search, and alphabetizing features. Data may be output to the screen or printer. Cassette, $7.50. Event Horizon Software (see address above).

Other Computers

Airport, an air-traffic simulation. This action game tests your skill as an air-traffic controller. Flight plans, landings, take-offs, or transits are all radioed to you. Guide 26 aircraft safely and you win. But violate FAA rules with a "near miss" and you're fired. For the Heath/Zenith operating systems and the Osborne 1; floppy disk, $19.95. The Software Toolworks, Suite 1118, 15233 Ventura Blvd., Sherman Oaks, CA 91403.

Pen-Pal, a word-processing program (see description under Apple). For the Franklin Ace; floppy disk, $59.95. Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46268.■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

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11. Deadline	$29.00
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13. Zork II	$29.00
14. 3-D Man	$14.00
15. Protector	$32.00
16. Starcross	$29.00
17. Easy Mail 64	$14.95
18. Grave Robber	$11.00
19. Wall Street	$19.00
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5. Dig Dug	$33.00
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7. Donkey Kong, Jr	$39.00
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12. Jumpman	$29.00
13. Shamus	$34.00
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17. Astro Chase	$25.00
18. Blade/Black Hole	$27.00
19. Pac Man	$33.00
20. Baja Buggies	$25.00
21. Crush, Crumble & Chomp	$24.00
22. Wayout	$27.00
23. Zork II	$29.00
24. Visicalc	$159.00
25. Atari Writer	$49.00
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34. Kindercomp	$21.00
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Clubs and Newsletters

Update for Human Services

People who work in the health and human services can subscribe to a newsletter, *Healthcare Microcomputing Network,* that intends to introduce improvements in microcomputer usage to healthcare facilities. Subscribers are linked with other health-related corporations through both the publication and *Network*'s on-line database service with emphasis on current specialized news about the microcomputer industry. The *Network* is published monthly by Cronin and Associates of Minneapolis, Minnesota. For further details, contact *Healthcare Microcomputing Network,* Suite 520, 6600 France Ave. S, Minneapolis, MN 55435, (612) 926-5827.

And Logo Goes On

The *National Logo Exchange (NLX)* is a monthly newsletter that provides practical ideas and tips for teachers who use the Logo language in their classrooms. The newsletter provides a forum for sharing Logo ideas, techniques, and philosophies. Articles are written by classroom teachers and professional educators to provide up-to-date reviews of recent Logo versions and resources. Subscriptions are $25 a year in the U.S., Canada, and Mexico, and $30 elsewhere. Contact the *National Logo Exchange*, POB 5341, Charlottesville, VA 22905.

Bimonthly Explorations

Owners of the Explorer-85 computer and S-100 bus can join a users group that produces a newsletter every two months called *Explorations.* New issues as well as back issues are available for $1 each. For details, contact Leroy W. Marshall, 808 Vassar Lane, Schaumburg, IL 60193, (312) 980-8980.

Pascal for Advanced Placement

A free newsletter is designed to share beneficial ideas for those who teach Advanced Placement Computer Science (APCS), which uses only Pascal. The *APCS Newsletter* will be produced monthly and will raise such issues as software in the classroom, teaching ideas, and materials for teaching introductory Pascal. Those interested are encouraged to send their name, address, and hardware description to Tim Corica, *APCS Newsletter,* The Peddie School, Hightstown, NJ 08520.

Computer Group Has Good News

The Christian Computer Users Association (CCUA) serves as a clearinghouse for information on software and systems of interest to Christian churches. It produces the quarterly *CCUA News,* operates a software exchange, and runs the computer-based Good News Information Service. A one-year membership costs $15. For more information, contact Douglas Vos, Christian Computer Users Association, 1145 Alexander St. SE, Grand Rapids, MI 49507, (616) 241-0368.

Timex/Sinclair in the Finger Lakes

A group for users of Timex/Sinclair computers is forming in the Finger Lakes region of New York state between Rochester and Syracuse. Anyone interested can send inquiries to Mark Tepper, 67 North Main St., Geneva, NY 14456.

Schools Use Microcomputers

The Center for Social Organization of Schools of the Johns Hopkins University of Baltimore, Maryland, prepares and distributes a newsletter entitled *School Uses of Microcomputers.* These reports from a national survey include charts on the percentage of teachers who are computerists, how many schools have computers, and the amount of use they receive during the day. It includes tables on the uses of drills and applications of microcomputers in elementary and secondary schools. For further information, contact Dr. Henry Jay Becker, Center for Social Organization of Schools, Johns Hopkins University, 3505 North Charles St., Baltimore, MD 21218.

Participants Welcome

People who are interested in joining a 68000-software users group that is forming in southern California are encouraged to contact Carl Cagan, 211 North El Camino Real, Suite 101C, Encinitas, CA 92024, (619) 942-0744.

Connect With Micro Decision Users

The Connecticut Micro Decision Users Group (CMDUG) of Orange, Connecticut, meets on the second Wednesday of every month for anyone interested in the Micro Decision computer. A subscription to the group's quarterly *CMDUG Newsletter* is included with membership. The fee is $12 per year. For details such as locations and times of meetings, contact Dave Mintie, CMDUG, 226 Boston Post Rd., Orange, CT 06477.

Color Computers in Philadelphia

A section of the Philadelphia Area Computer Society (PACS) is called the Color Computer Users Group. It meets on the third Saturday of the month at 10 a.m. in the Science Building of LaSalle College. Further information is available from Arnold Weiss, Apt. 1626, Kennedy House, 1901 J. F. Kennedy Blvd., Philadelphia, PA 19103.

Louisiana IBM PC Users Group

The NW Louisiana IBM Personal Computer Users Group meets on the third Tuesday of each month at 7 p.m. For further information on the club's activities, contact Harry Friedman, NW Louisiana IBM Personal Computer Users Group, 945 Dudley Dr., Shreveport, LA 71104.

For Friendly Folks

Follklore is a quarterly publication circulated to all subscribers and members of FOLLK. Designed for Friends of LISP/Logo Kids (FOLLK), it contains articles, columns, and code that relate to the expanding field of artificial intelligence. The group has a hotline and a bulletin-board system. Membership is $15 a year for students and senior citizens,. $25 for a regular membership, and $100 for companies or institutions. A subscription to *Follklore* alone is $7.50. For details, contact FOLLK, Friends of LISP/ Logo Kids, 254 Laguna Honda Blvd., San Francisco, CA 94116.

Group for the TI 99/4A

The International 99/4A Users Group (IUG) is seeking members and people interested in the TI 99/4A. The group produces a bimonthly newsletter called *4A Forum.* Submissions to the newsletter are welcome. The annual membership fee is $5. For details, contact Jim Robinson, International Users Group (IUG), 1778 Hays Dr., Louisville, CO 80027.

Osborne Group in Chicago

Chicago's First Osborne Group (CFOG) meets regularly and produces a monthly newsletter entitled PIP (Peripheral Interchange Program) that includes interviews, an events calendar, software reviews, and articles. Contributions to the newsletter are welcome. The club provides a bulletin-board service to members, and membership is open to anyone for $20 annually. Contact CFOG, Rob Troxel, POB 943, Libertyville, IL 60048, (312) 356-6889.

Meet with Antelope

The Antelope Valley Commodore User Group meets on the first Saturday of every month. For further details, contact Jim Haner, Antelope Valley Commodore User Group, POB 4436, Lancaster, CA 93539, (805) 942-2626.

HBO in Canada for the Atari

The Hamilton, Burlington, Oakville (HBO) Atari User Group meets on the third Wednesday of each month at the Port Nelson United Church Hall, 3132 South Drive, Burlington, Ontario. A newsletter is produced that contains details about meetings, book reviews, and club business. Membership fees are $25 annually for individuals and $35 for a family. If you wish to attend a meeting a $4 fee will be charged. For information, contact William Morris, 67 Moxley Dr., Hamilton, Ontario L8T 3Y8, Canada, (416) 388-3552.

New Delhi Enthusiasts

A home computer users club, the ZX Club, meets twice a month in New Delhi, India, to exchange the news and solve problems encountered by users of the ZX81. Owners and users of any home computer are welcome, however. The members of the club have developed a music program for the ZX81. For further details, contact ZX Club, h-35 d Saket, New Delhi 110 017, India.■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

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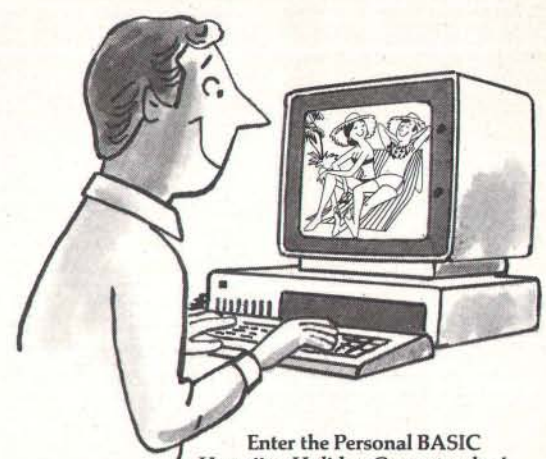

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WHY YOU SHOULD RECOMMEND A KAYPRO EVEN IF YOU DIDN'T BUY ONE YOURSELF.

If you're happy with the computer you now own, we're happy for you. Because we both know what you went through to buy it.

More than likely, it was a long year's education that sent you into a complex maze of trial and error. You spent a lot of time asking questions in computer stores. More time hunting for answers in computer books. Even more time investigating all the hardware, let alone software options you had to consider.

It was a hard way to get what you needed. A year that earned you an honorary degree in computer engineering and the status of a computer buff.

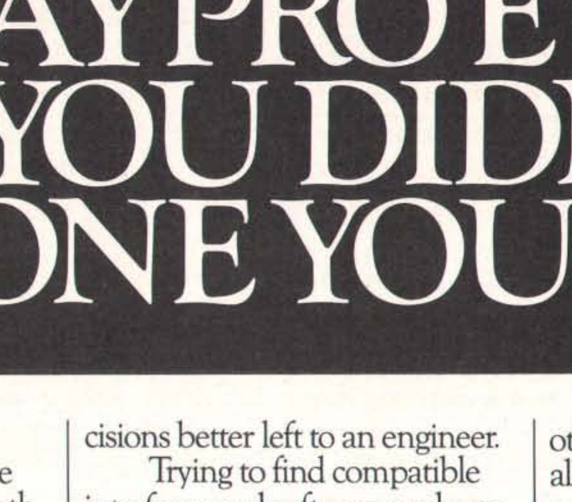
But just between us buffs, would you recommend a year like that to a friend?

FOR THE FIRST-TIME BUYER, KAYPRO IS A GODSEND.

We think the 'hard way' is the wrong way to have to buy a computer. After all, a business person shouldn't be required to make decisions better left to an engineer.

Trying to find compatible interfaces and software packages alone would drive most people up the wall (remember?).

So, we've taken a different approach to making and selling our Kaypro II. Rather than a starter system, with options you buy piece for piece, it's designed with all the integrated hardware and software it needs to be fully functional.



Off the shelf, Kaypro II is completely ready for business. We think that's what the first-time buyer really needs.

IT'S A COMPLETELY INTEGRATED SYSTEM.

Since we don't consider a monitor, disk drives, interfaces or other hardware as optional extras, all Kaypro's hardware comes complete in an integrated system. Except, of course, for a printer. As you know, some people don't need one. And those who do must decide whether they need dot matrix or letter quality printing.

What's complete on a Kaypro II?

64K RAM, Z-80 microprocessor. A 9" green screen monitor. Dual disk drives, the same used by IBM. A detachable keyboard that's more complete than you'll find on the latest Apple. Built-in interfaces for both a printer and communications.

In other words, all the hardware you'd recommend to a first-time buyer. In one complete package.

IT COMES COMPLETE WITH SOFTWARE.

While businesses can be very different, the fact is that 95% of all business needs can be fulfilled by a series of three business applications programs. Word Processing/Spelling, Data Base Management and Financial Spreadsheeting.

It's the software that's optional with other computers.

Registered Trademarks: Apple – Apple Computer, Inc., IBM – IBM Corp., CP/M – Digital Research, Inc., Z-80 – Zilog, M-Basic – Microsoft, Inc., Tandy, TRS-80 – Tandy Corporation, Osborne – Osborne Computer Corporation, Xerox – Xerox Corporation. Prices based on published information as of July 15, 1983. © 1983 Kaypro Corporation.

But it too comes complete with a Kaypro.

And with its CP/M operating system, Kaypro II is capable of running thousands of other business programs, to fill more specialized needs.

IT SELLS FOR $1595, COMPLETE.

People are bound to ask you how much they should spend on a computer. There is, of course, an obvious answer: as little as possible and still get a serious business system, complete with all the functions they need.

At $1595, Kaypro II is the least expensive serious business system we know of on the market today.

There are basic starter systems advertised for less. But their optional hardware and software can double or triple their basic price. So they can end up costing $2000-$3000 more than a Kaypro.

A good example is an Apple IIe. With a hardware configuration comparable to Kaypro II's, complete with comparable software, it lists for an average price of $4400. $2805 more than a Kaypro.

IT OFFERS MORE MEMORY FOR THE MONEY.

Since disk drive memory capacity is always a concern, once again the idea is to get the most for the money. With two disk drives, Kaypro II gives you 400K for $1595. With equivalent hardware, an IBM gives you 320K for about $2800. And Apple IIe gives you 286K for about $2400.

So once again, Kaypro II delivers.

IT HAS POWER TO SPARE FOR WHAT MOST BUSINESSES NEED.

The more you love computers, the more tempting it is to recommend a 16-bit vs. 8-bit machine. You know that 16-bit systems are a little faster and have more power to run longer programs.

However, 16-bitters are far more expensive than the 8-bit variety. And, unfortunately, have only a handful of business applications software packages that really take advantage of them.

SPECIFICATIONS

Microprocessor
Z-80
Operating System
CP/M 2.2
User Memory
64K
Disk Drives:
2 drives, 400K, unformatted
Interfaces
1 Serial
1 Parallel
Keyboard
Detached, 63-key with numeric keypad
Software included:
Perfect Writer word processing
Perfect Speller
Perfect Filer
Perfect Calc spreadsheet
Wordstar word processing
The Word Plus
Profit Plan spreadsheet
M-Basic
12 Games
Uniform—allows computer to 'read' and 'write' TRS-80, Osborne, Xerox disks
Dimensions
Height: 8 inches
Width: 18 inches
Depth: 15½ inches
Weight: 26 lbs. (portable)

Considering the real needs and budget limitations of most small businesses, why suggest a company limo when a good company car will do?

Since 75% of all micros sold today are 8-bit systems, it's indicative of their capacity to take care of business. We'd stick with a Kaypro II.

IT CAN PAY FOR ITSELF FASTER THAN MORE EXPENSIVE COMPUTERS.

Every business person wants a computer to pay for itself in increased productivity. And the faster the better. Perhaps on this count alone, Kaypro II is worth recommending.

As a fully functional business system for $1595, Kaypro can win the payout race hands down.

IT'S BECOME A LEADING SELLER THANKS TO COMPUTER BUFFS, LIKE YOU.

In fact, Kaypro II is one of the best sellers in the $1000-$5000 price range. And it got there largely because of the enthusiastic word of mouth, and word of press, of computer enthusiasts. Many of whom, after building their own systems, bought a Kaypro II as their second computer.

So you certainly won't be alone if you recommend Kaypro II to anyone shopping for a first computer.

Or look at it this way. Once you tell people about the complete business computer for $1595, they'll probably stop bugging you with a lot of questions.

They may even forget to ask why you didn't buy a Kaypro II for yourself.

Just between us buffs, we can't recommend a good answer for that.

CALL 800-447-4700 FOR THE DEALER NEAREST YOU.

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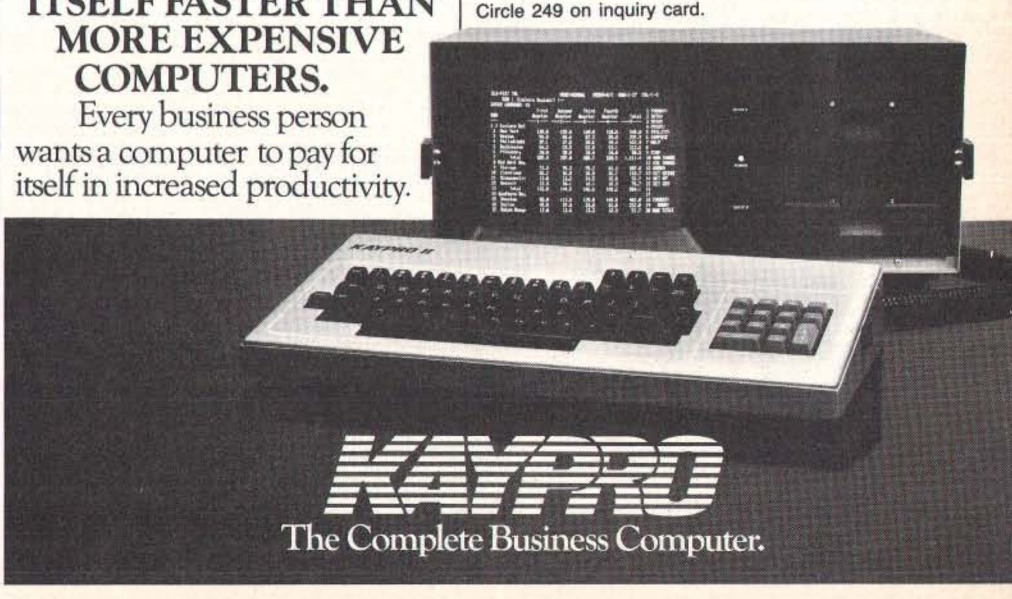

KAYPRO

The Complete Business Computer.

Books Received

The ABZ's of Word Processing for Executives and Professionals, Robert M. Segal and Susan B. Kelley. New York: Stravon Educational Press, 1983; 64 pages, 21.5 by 28 cm, softcover, ISBN 0-87396-097-1, $10.95.

Applesoft Language, 2nd ed. Brian D. Blackwood and George H. Blackwood. Indianapolis, IN: Howard W. Sams & Co., 1983; 280 pages, 15 by 23 cm, softcover, ISBN 0-672-22073-3, $13.95.

Astrology: A Look into the Future, Sam D. Roberts. Holzkirchen, West Germany: Ing. W. Hofacker GmbH, 1982; 140 pages, 13 by 20.5 cm, softcover, ISBN 3-88963-171-1, $9.95.

BASIC By Design, Andrew Kitchen. Englewood Cliffs, NJ: Prentice-Hall, 1983; 514 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-060269-8, $18.95.

BASICally Speaking—A Young Person's Introduction to Computing, Frances Lieberman Cohen. Englewood Cliffs, NJ: Prentice-Hall, 1983; 144 pages, 21.5 by 27.8 cm, softcover, ISBN 0-8359-0333-9, $12.95.

The Blue Book for the Apple Computer, 3rd ed. Chicago, IL: WIDL Video Publications, 1983; 850 pages, 21 by 27.5 cm, softcover, ISBN 684-17927-X, $24.95.

Byting Back, Rick Geary. Solana Beach, CA: Valleyware Publishing, 1983; 104 pages, 21.5 by 13.5 cm, softcover, ISBN none, $3.95.

Computers and Data Processing: Introduction with Basic, 3rd ed. Keith Carver. New York: John Wiley & Sons, 1983; 544 pages, 17.5 by 25.3 cm, softcover, ISBN 0-471-09834-5, $19.95.

The Computer Careers Handbook, Connie Winkler. New York: Arco Publishing Inc., 1983; 160 pages, 20 by 26 cm, softcover, ISBN 0-668-05530-8, $7.95.

Computers for Small Business, Gary Bencar. Santa Barbara, CA: La Cumbre Publishing Co., 1983; 158 pages, 13.5 by 21.5 cm, softcover, ISBN 0-935222-05-7, $9.95.

Computer Graphics and Reporting Financial Data, Irwin M. Jarett. New York: John Wiley & Sons, 1983; 376 pages, 22 by 29 cm, hardcover, ISBN 0-471-86761-6, $49.95.

Computer Programs for Electronic Analysis and Design, Dimitri S. Bugnolo. Reston, VA: Reston Publishing Co., 1983; 272 pages, 17.5 by 23.3 cm, softcover, ISBN 0-8359-0874-7, $16.95.

Computer Programs for Machine Design, Robert J. Wenzel. Indianapolis, IN: Howard W. Sams & Co., 1982; 276 pages, 21 by 27.5 cm, softcover, ISBN 0-672-21960-3, $21.95.

The Data Factory, Edward G. Roeske. New York: Yourdon Press, 1983; 104 pages, 15.5 by 22.5 cm, softcover, ISBN 0-917072-34-0, $17.

The Directory of Office Information Systems, 2nd ed. Association of Information Systems Professionals. New York: Information Clearing House, 1983; 310 pages, 21.5 by 28 cm, softcover, ISBN 931634-02-4, $34.95.

The Easy Guide to Your Apple II, Joseph Kascmer. Berkeley, CA: Sybex, 1983; 160 pages, 14 by 21 cm, softcover, ISBN 0-89588-122-5, $9.95.

8088 Assembler Language Programming: The IBM PC, David C. Willen and Jeffrey I. Krantz. Indianapolis, IN: Howard W. Sams & Co., 1983; 240 pages, 20.5 by 23.5 cm, softcover, ISBN 0-672-22024-5, $15.95.

Encyclopedia of Computer Terms, Douglas Downing. Woodbury, NY: Barron's Educational Series Inc., 1983; 160 pages, 13.5 by 20.5 cm, softcover, ISBN 0-8120-2519-9, $6.95.

Fancy Programming in Applesoft, Gabriel Cuellar. Reston, VA: Reston Publishing Co., 1983; 272 pages, 15 by 23 cm, softcover, ISBN 0-8359-1856-4, $14.95.

The Foolproof Guide to SCRIPSIT Wordprocessing, Jeff Berner. Berkeley, CA: Sybex, 1983; 208 pages, 18 by 23 cm, softcover, ISBN 0-89588-098-9, $11.95.

How to Buy a Business Computer and Get It Right the First Time, Edward M. Cross. Reston, VA: Reston Publishing Co., 1983; 224 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-2922-1, $14.95.

The Illustrated CP/M-Wordstar Dictionary, Russell A. Stultz. Englewood Cliffs, NJ: Prentice-Hall, 1983; 272 pages, 15 by 22.5 cm, softcover, ISBN 0-13-450528-X, $14.95.

Learning Simulation Techniques on a Microcomputer, Pat Macaluso. Blue Ridge Summit, PA: Tab Books, 1983; 154 pages, 13 by 21 cm, softcover, ISBN 0-8306-1535-0, $10.95.

Microcomputer Controlled Toys & Games & How They Work, Van Waterford. Blue Ridge Summit, PA: Tab Books, 1983; 240 pages, 13 by 21 cm, softcover, ISBN 0-8306-1407-9, $9.95.

Microcomputer Graphics, Donald Hearn and M. Pauline Baker. Englewood Cliffs, NJ: Prentice-Hall, 1983; 320 pages, 18.5 by 24.5 cm, hardcover, ISBN 0-13-580670-4, $24.95.

Microcomputers in Large Organizations, Thomas

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William Madron. Englewood Cliffs, NJ: Prentice-Hall, 1983; 192 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-580787-5, $12.95.

Microcomputers on the Farm, Jack O. Beasley. Indianapolis, IN: Howard W. Sams & Co., 1983; 208 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-22011-3, $14.95.

Minute Manual for Apple Writer II, Jim Pirisino, Columbia, MD: Minuteware, 1983; 100 pages, 14 by 21 cm, softcover, ISBN none, $7.95.

The Official Silicon Valley Guy Handbook, Patty Bell and Doug Myrland. New York: Avon Books, 1983; 128 pages, 13.5 by 20.5 cm, softcover, ISBN 0-380-84392-7, $3.95.

Powers of Ten, Philip Morrison and Phylis Morrison and the Office of Charles and Ray Eames. New York: Scientific American Books Inc., 1983; 176 pages, 22 by 24 cm, hardcover, ISBN 0-7167-1409-4, $29.95.

The Pre-computer Book, F.A. Wilson. London, England: Bernard Babani Ltd., 1983; 96 pages, 17.8 by 11 cm, softcover, ISBN 0-85934-090-2, £1.95.

Science and Engineering Programs for the Timex/Sinclair 1000, Cass Lewart. New York: Micro Text/McGraw-Hill, 1983; 120 pages, 15 by 23 cm, softcover, ISBN 0-07-037444-9, $13.95.

Simplified Guide to Small Computers for Business, Daniel R. McGlynn. New York: John Wiley & Sons, 1983; 256 pages, 17.5 by 25 cm, softcover, ISBN 0-471-86853-1, $14.95.

6502 Systems Programming, Thomas G. Windeknecht. Boston, MA: Little, Brown and Company, 1983; 256 pages, 17.8 by 23.5 cm, softcover, ISBN 0-316-94563-3, $14.50.

Skarbek Software Directory, 3rd ed. Anna and Joe Skarbek. St. Louis, MO: Skarbek Corp. Inc., 1982; 448 pages, 13.5 by 21 cm, softcover, ISBN none, $14.95.

Soul of CP/M, Mitchell Waite and Robert Lafore. Indianapolis, IN: Howard W. Sams & Co., 1983; 400 pages, 18.5 by 23 cm, softcover, ISBN 0-672-22030-X, $18.95.

TRS-80 Color Computer Interfacing With Experiments, Andrew C. Staugaard Jr. Indianapolis, IN: Howard W. Sams & Co., 1983; 206 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21893-3, $14.95.

Using & Programming the TI-99/4A, Frederick Holtz. Blue Ridge Summit, PA: Tab Books, 1983; 224 pages, 19.5 by 23.5 cm, softcover, ISBN 0-8306-0620-3, $9.95.

Using COBOL in an MP/M System, Neil C. Gelb, CDP. Indianapolis, IN: Howard W. Sams & Co., 1983; 112 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21936-0, $12.95.

VAX-11 Assembly Language Programming, Sara Baase. Englewood Cliffs, NJ: Prentice-Hall, 1983; 416 pages, 18.5 by 24.5 cm, hardcover, ISBN 0-13-940957-2, $26.95.

Z80 Assembly Language Subroutines, Lance A. Leventhal and Winthrop Saville. Berkeley, CA: Osborne/McGraw-Hill, 1983; 497 pages, 18.5 by 23.5 cm, softcover, ISBN 0-931988-91-8, $15.95. ■

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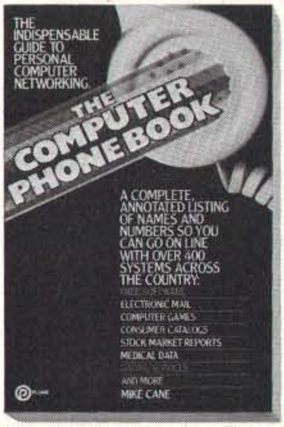

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(1a)

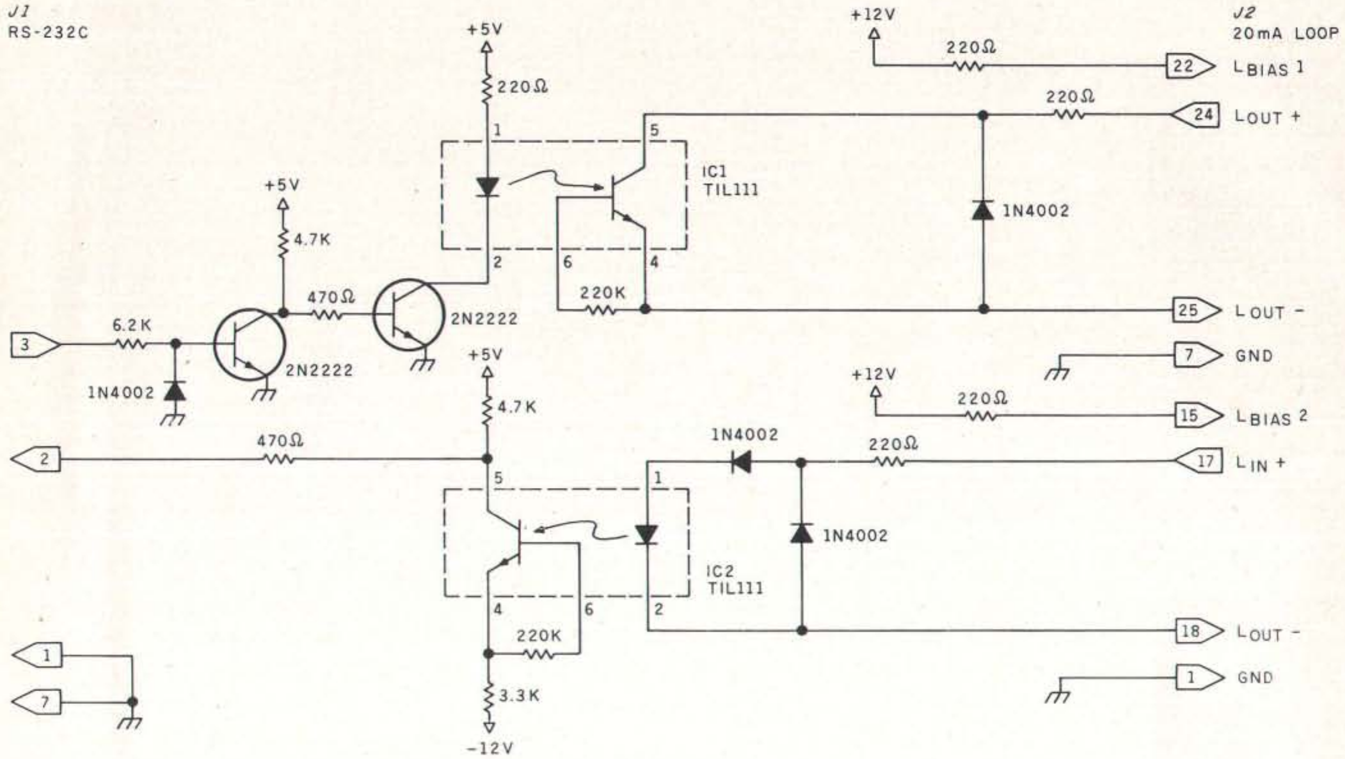
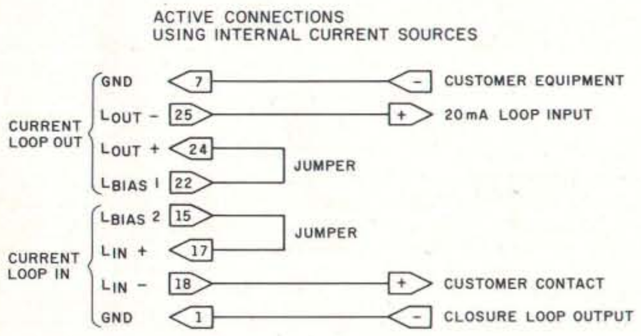


Figure 1: *Figure 1a shows the computer serial output to 20-mA loop conversion. Figure 1b shows the active connections for use with internal current sources. Figure 1c shows the passive connections for use with external current sources.*

(1b)



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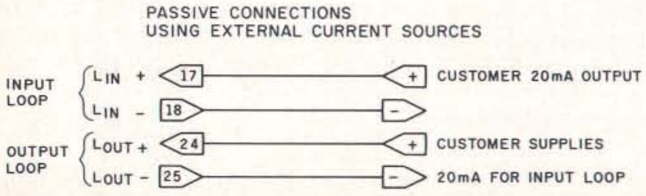

Apple-Teletype Connections

Dear Steve,

Can you direct me to an article that shows how to connect an Apple II Plus to a Teletype Model 33ASR terminal? Because I already have an 8251A USART (universal synchronous/asynchronous receiver/transmitter), I'd prefer to use one if possible.

Specifically, I need to know details about addressing and how to print out program listings and results. My application involves punch tapes for machine tools. Thanks for your help.

Dave Madalozzo
Tarboro, NC

The simple schematic diagram and connection drawings shown in figure 1 convert the serial output of a computer to a 20-mA loop suitable for driving Teletype machines. The circuit features optoisolators to avoid any chance of an electrical failure in the Model 33ASR damaging the computer. I assume that you have the serial port because several cards for the Apple that provide this feature are available. A printed-circuit board with the components of figure 1 is available from The Micromint (561 Willow Ave., Cedarhurst, NY 11516, (800) 645-3479; in New York, (516) 374-6793). For a more detailed analysis of RS-232C and current-loop interfacing, see "The Current-Loop Interface" portion (page 170) of "Welcome to the Standards Jungle" by Ian H. Witten (BYTE, February 1983, page 146). . . . **Steve**

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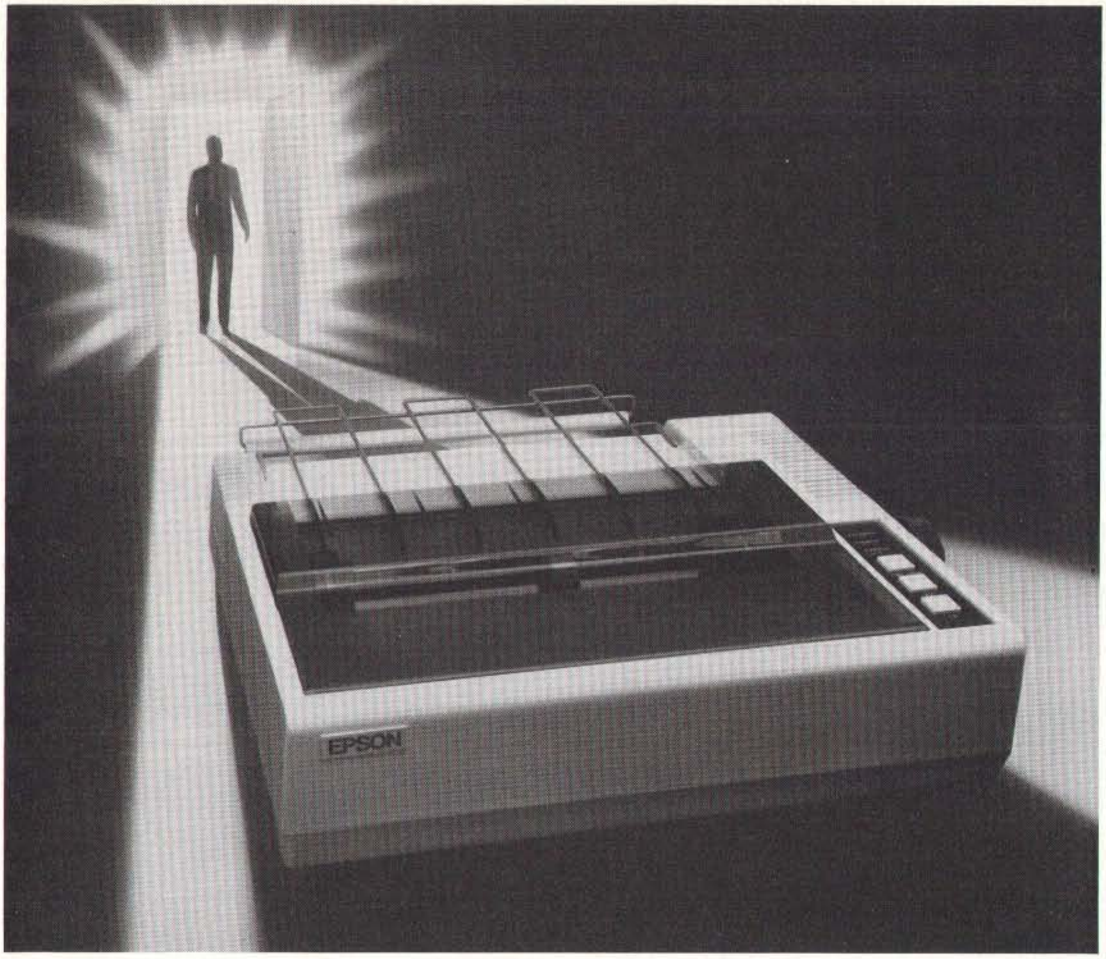

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Real-Time Solution

Dear Steve,

I attempted to interface the MM58167A real-time-clock chip to my Ferguson Big Board computer as described in your article "Everyone Can Know The Real Time" (BYTE, May 1982, page 34). The circuit worked the first time on power-up. Satisfied, I put the interface aside and went on to other things.

After several months, I decided to reconnect the interface; that's when I began experiencing the same problem that Mr. Edward Beighe (Ask BYTE, April 1983, page 465) was having. The seconds counter was stuck on hexadecimal FF while the other counters seemed to be working correctly. Thinking I had blown the chip, I purchased another one—with data sheets. The second chip produced the same erroneous results.

Over the period of time that I had not used the real-time clock, I had made several changes to my Big Board, one of which was increasing the clock rate from 2.5 MHz to 3.5 MHz. The data sheets for the MM58167A state that the maximum time from ready strobe inactive to data valid is 800 ns, which I interpreted to mean that it could take 800 ns before data is ready. I changed my board back to 2.5 MHz and both clock chips worked! After repeatedly verifying that the clock would work at 2.5 MHz but not 3.5 MHz, I made an addition to the original clock circuit (see figure 2). The circuit has worked perfectly at 3.5 MHz ever since.

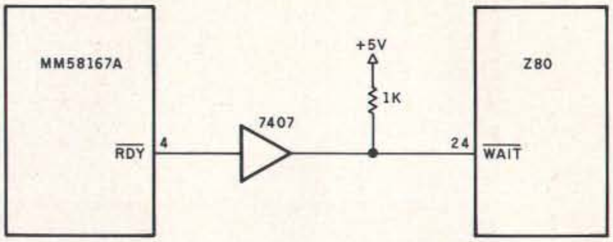

Figure 2: *A remedy for real-time clock-timing problems on higher-speed systems.*

I hope this helps Mr. Beighe and others with timing problems.

Ronnie Kelly
Chicago, IL

Thank you very much for your solution to Mr. Beighe's problem. He did not mention how he was driving the chip, but 800 ns is a relatively long access time, and wait states should be employed with faster clock rates. Your solution is simple and correct. . . . **Steve**

CMOS Microprocessor

Dear Steve,

Last month I bought an Epson HX-20 notebook-sized computer. Epson advertises that the HX-20 has two CMOS 6301 microprocessors. I've never heard of a 6301 and no one I asked seems to know either. Can you give me the facts? Thanks.

Brad Kulp
Landover Hills, MD

The 6301 microprocessor used in the Epson HX-20 is a CMOS version of the Motorola 6801 microprocessor. CMOS (complementary metal-oxide semiconductor) chips are used throughout the computer to keep the power consumption at a low level.

A product description of the Epson HX-20, by Gregg Williams, appeared in the April 1982 BYTE on page 104. It was an introductory review but it describes many of the features of the unit. . . . **Steve**

IMSAI Manuals

Dear Steve,

I recently bought an IMSAI system with serial I/O, revision 3, circa 1976, with twin Intel 8251 USARTs (universal synchronous/asynchronous receiver/transmitter). The manual is missing, and IMSAI, alas, is no longer among us. With a little help from my friends, there was no problem tracing the modem signals on the PCB. The "old-timer" is now plugged in and working, but I still would like a copy of the manual.

Is there some place where I can buy manuals for vintage products?

Gisle Hannemyr
Tromso, Norway

Microsystems *magazine features advertisements by a company that has taken over the line of IMSAI computers. It should be able to furnish the documentation that you require. Write or call IMSAI Computer Division, Fischer-Freitas Corporation, 910 81st Ave., Bldg. 14, Oakland, CA 94621, (415) 635-7615. . . .* **Steve**

Modem Musings

Dear Steve,

As a computer technician, I know how much time and energy go into your projects. I appreciate the work you are doing very much.

I am writing to you on two subjects. The first is the ECM-103 modem (BYTE, March 1983, page 26):

1. The RS-232C interface in it has no control signals such as RTS (request to send) and CTS (clear to send). How does communication take place?
2. How do I add ring detection?
3. Where can I get a DAA (data-access arrangement), and what should I expect to pay?
4. Can I just connect the telephone interface to the base of a regular telephone?
5. I would like to be able to auto-dial by sending ASCII (American National Standard Code for Information Interchange) strings to the modem. I thought about using an 8085 processor because of its built-in serial port. Do you have any suggestions?

I have an H-89 with the serial port on a wire-wrap board and will put this circuit on the same board, so I have a lot of flexibility in what I do.

The second subject concerns future projects. I would like to see a 68000-based system with DMA (direct memory access), math processor, priority interrupt, hard- and soft-disk controllers, and everything else one could want. It would also be able to use a 32-bit databus version of the 68000 when they become cost-effective. I also would like to see it use the Motorola Versabus and Unix. Maybe it could have an 8-bit processor to handle the I/O. In fact, I would like to have seen this

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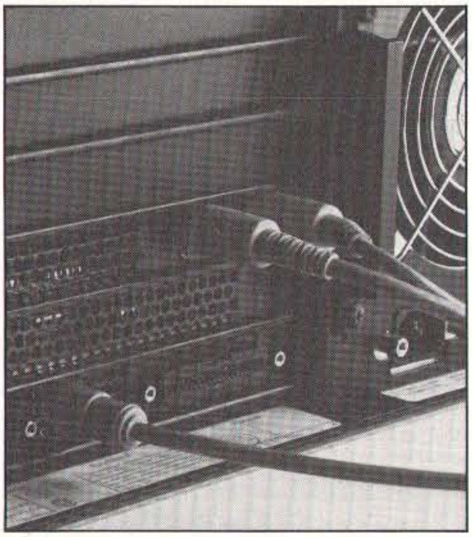

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instead of the MPX-16. I think we have enough IBM PC clones.

Again, thank you for your efforts.

Bob Iacullo
Doylestown, PA

The ECM-103 and other modems use two sets of tones and operate in a full-duplex mode. Because this method allows the simultaneous transmission and reception of data, no handshaking signals (RTS and CTS) are needed.

The circuit shown in figure 3 provides a simple means of ring detection. The article from which this circuit was taken appeared in the February 20, 1975 issue of Electronics. *It is titled "Optically coupled ringer doesn't load phone line." In it, William D. Kraengel Jr. illustrates a simple way to capture a high-voltage signal and safely convert it to TTL or CMOS levels. While this circuit drives an oscillator, it could just as easily toggle a counter and trip on a preset number of rings.*

A DAA can be obtained from your local telephone company or any of several manufacturers. They must be FCC-certified and vary in price. I have seen some as low as $50 in quantities of 10,000. Single quantities must be quoted. One source for a DAA is Cermetek Microelectronics Inc., 1308 Borregas Ave., Sunnyvale, CA 94086. The telephone interface can be connected to the base of a regular telephone.

Many articles have been published on auto-dialing. If yours is a Touch Tone system, see my article on page 42 of the December 1981 BYTE. "Build a Touch Tone Decoder for Remote Control" gives information on an encoder circuit. Such a circuit can be driven from a parallel port (or serial port, through a UART). If it is a pulse-dialing (rotary) telephone system, the pulses can easily be generated in software.

At the time that I designed the MPX-16, there was considerably more hardware and software information available for the 8088 processor. With the introduction of the IBM PC, a plethora of accessory boards was flooding the market and it seemed unnecessary to "reinvent the wheel.". . .**Steve**

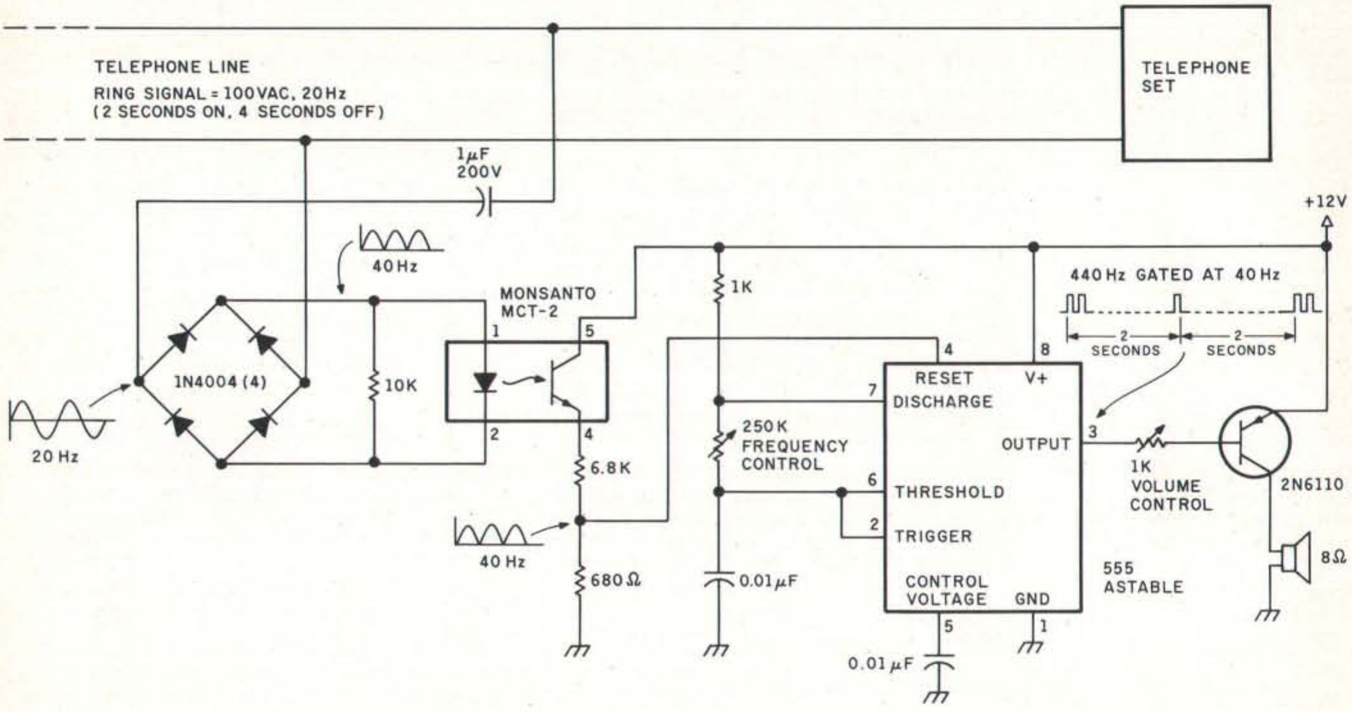

Figure 3: *The ring-detection circuit is useful for detection of high-voltage signals and conversion to common logic levels.*

High-Speed Communications

Dear Steve,

I read your June 1983 BYTE article (page 35) "Use ADPCM for Highly Intelligible Speech Synthesis" with great interest. I'm particularly interested in the possibility of developing a method of transmitting not only high-quality voice signals through a 32-kbps (thousand bits per second) digital channel, but also high-speed (9600-bps) modem traffic.

"The Return of TELPAK," printed in the March 1983 issue of *Telecommunications* magazine (authored by Ivan Riley of Aydin Monitor Systems), claims that although 32-kbps ADPCM is capable of handling 4800-bps modems, it cannot pass 9600-bps traffic (CCITT V.29). The same article claims that a technique referred to as VQL (variable quantization level) encoding is capable of 9600-bps transmission.

I would appreciate any information you may have or to which you can refer me that deals with VQL or the general topic of systems designed to pass analog voice and modems through 32-kbps communications links.

Christopher Paul
Bayport, NY

The August 1983 issue of Sys-

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tems and Software, *devoted to combining voice and data communications, features a special report on that subject. In addition, many advertisements feature devices that handle both voice and data transmissions.*

The magazine can be obtained from Hayden Publishing Company Inc., 50 Essex St., Rochelle Park, NJ 07662. Subscriptions are offered free of charge to qualified subscribers, and single issues can be obtained at $4 each. . . . **Steve**

Ukrainian Word Processing

Dear Steve,

In addition to doing word processing in English, I am looking for a computer with which I could do word processing in Ukrainian as well. I wrote to you since my problem with foreign-language character generation might best be solved through hardware. While there are software programs for various character generators, I still haven't found one with which it is possible to do word processing. C. Kenneth Fan, for example, had an article, "An IBM Character Generator," in the January 1983 *Creative Computing.* His program requires at least 96K bytes of ROM for work space—whereas this space is also used by some of the more powerful word-processing programs.

I plan to get a microcomputer in the near future, and I want to know if there is a computer on the market that supports foreign-language character sets. Ukrainian uses the Cyrillic alphabet, so I need a complete character set and not just accents and a few special characters. Do you know of any monitor with a user-definable character set? The Epson QX-10 changes its character set from normal to bold or italic; I suppose that this is done through an alternate character generator. Wouldn't it be possible to do the same thing with another alphabet?

I already have an Olympia ES105 KRO electronic typewriter with a general-purpose interface that can be set for either serial or parallel operation. I also have a Russian print wheel that I am going to convert to Ukrainian.

Please let me know which computer you think would be easiest to work with. If you have any suggestions or ideas, I would appreciate your advice.

Thank you.

(Rev.) Maxim M. Kobasuk
Glen Cove, NY

The Victor 9000 computer has a software-generated character set that is loaded when the system is first initialized. Utilities are available for creating characters interactively and for installing them in an operating system. This feature will allow you to create whatever character set you desire. Since it is a one-for-one substitution, it should not affect the word-processing program.

Apple II, Atari, and other computers with graphics capability can create alternate character sets in software but must be patched into your existing word-processing program in order to be effective for screen display.

Additional information on the Victor 9000 can be obtained from Victor Business Products, 3900 North Rockwell St., Chicago, IL 60618. . . . **Steve**

Macro Micro Display

Dear Steve,

I am looking for a means of either projecting a black-and-white video-display image using rear-screen projection or implementing a light-display system similar to those used in stadium scoreboards. I would like to interface my IBM PC to the system to provide real-time display information at conferences and conventions.

Requirements for the system include character heights of not less than 6 inches, a maximum cost of $500, and high visibility in a well-lighted environment. Any suggestions? Thank you.

Bert Whittier
Melrose, MA

Electrohome Electronics manufactures a projection TV monitor that can be driven by any microcomputer. This would seem to be the simplest solution to your problem; however, I prefer not to quote its cost. Call or write them for additional information at Electrohome (U.S.A.) Limited, 182 Wales Ave., Tonawanda, NY 14150, (716) 694-3332. . . . **Steve**

Atari Parallel Interface

Dear Steve,

I've heard rumors that a printer interface can be built for Atari personal computers by using the number 3 and 4 controller jacks, and that a company is producing such a product. So far, however, I have been unable to locate any such company.

Do you have a schematic or know of anyone who is familiar with such an interface? I assume the interface is serial, but is a parallel interface possible using the controller ports? Thanks.

Ron M. Yoakem
Bainbridge, OH

Macrotronics makes a product that will enable the Atari 400 or 800 to drive a parallel printer through the front controller connector, without the need for the Atari 850 or a similar interface. A short driver program directs all LPRINT commands to the parallel-printer interface. It is compatible with BASIC, DOS, and ASSEMBLER/DEBUG. The address is Macrotronics Inc., 1125 North Golden State Blvd., Turlock, CA 95380, (209) 667-2888. . . . **Steve**

Math Language

Dear Steve,

I am having trouble finding a microcomputer language that handles complex arithmetic. As I am currently changing systems, the available languages will have some effect on what I purchase. I'd appreciate any help you can provide.

Stuart Sands
Berkeley, CA

FORTRAN IV has a COMPLEX function, but it is not implemented on microcomputer versions. I have been told by a professional programmer that the mainframe implementation is so slow that he writes his own routines; it is not very difficult. All that is necessary is to compute the real and imaginary parts separately, and then add them. This may be the easiest solution to your search. . . . **Steve**

Scope Your Data

Dear Steve,

How can I determine the data rate, parity, and stop-bit characteristics being transmitted by a computer over an RS-232C port by examining these signals on an oscilloscope?

Chuck Gollnick
Pullman, WA

Determining the data rate of a data signal by using an oscilloscope is very easy. Send a series of characters with lots of "ones" in its binary code. The question mark (?) is hexadecimal

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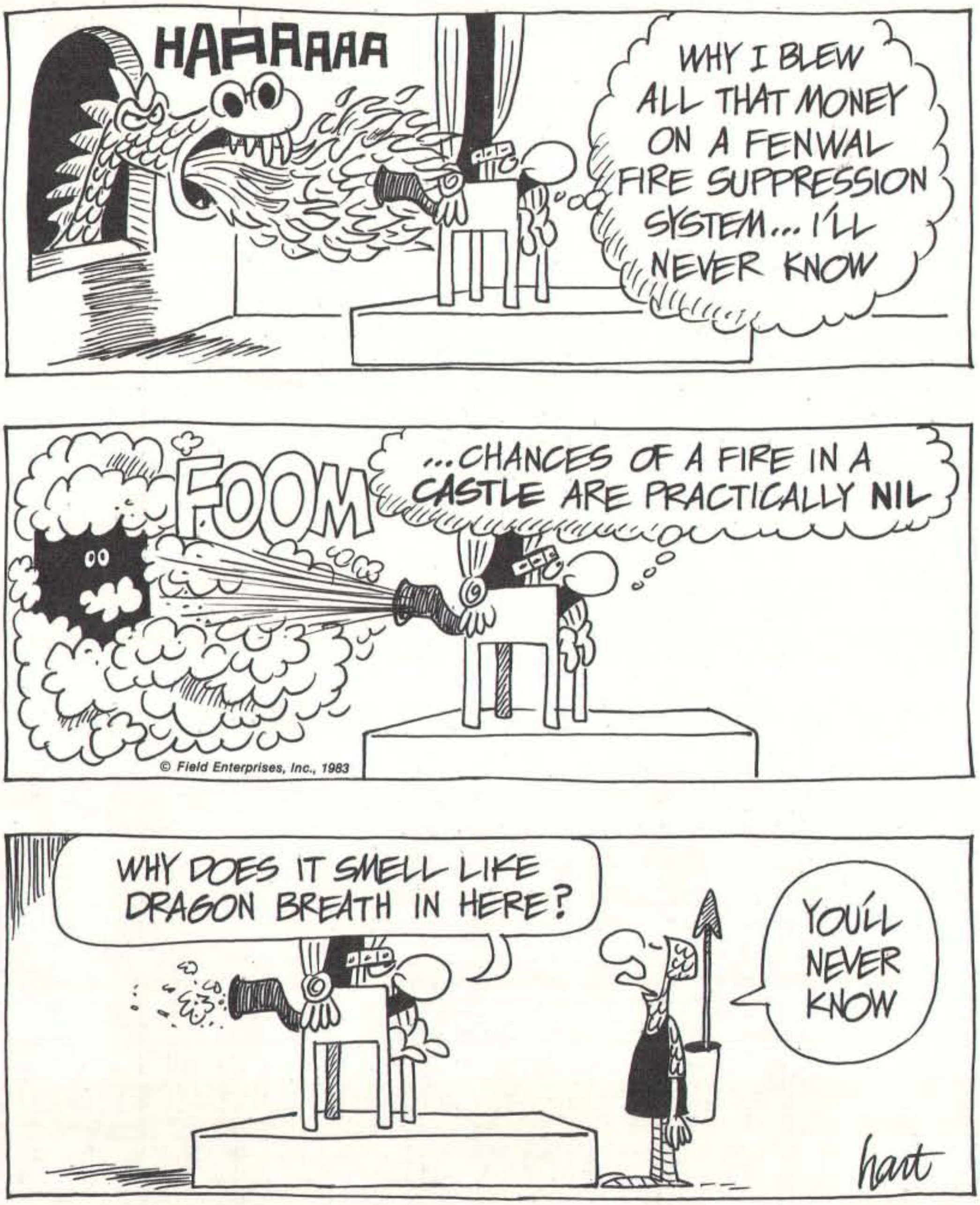
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ASCII code 7F (01111111) and makes a good choice. Set the sweep rate on the scope so that these "one" pulses are stable and note the number of time-base divisions between any two adjacent pulses on the scope screen. The result should be in the "1 bit in so many milliseconds" range for typical transmission rates. The inverse of this value is the data rate.

Determining the parity and stop-bit characteristics is more difficult since the waveform is not steady. A storage scope would be necessary for such a measurement.

*A hardware latch to hold one data word for inspection and a software routine are other methods of determining parity and stop bits. . . .***Steve**

Big Board Speaks

Dear Steve,

I am assembling a custom Z80 system for use by my wife who suffers from a paralyzed palate and can no longer speak. She will be able to communicate with me by typing and, by using a modem, will be able to contact me at my office, where I have a microcomputer and modem available. In order to become thoroughly familiar with the hardware (and to save a little money), I plan to assemble a kit. I have chosen the Ferguson Big Board for the main board. I need advice about which disk drives to use, as all my experience has been on large, mainframe timesharing systems.

The Big Board kit has an on-board Western Digital 1771 disk controller, and the documentation calls for a "Shugart Series 800 compatible" drive. The recording format is single-density IBM 3740. I do not have ready access to literature covering these specifications. I would be very grateful if you could tell me where I can find the necessary information to guide me in purchasing a suitable pair of drives at a reasonable price. Are double-sided drives practical in this application?

I read with great personal interest your two articles in BYTE (September and October 1982) on the voice simulator and plan to make this my first project once the basic system is running.

Walter Brouillette
Jamesville, NY

The Shugart 801 disk drive is a perfect companion for the Ferguson Big Board or virtually any system that uses the Western Digital 1771 controller. It is an extremely popular drive and is sold by nearly all mail-order computer stores. They are available as a bare drive or in a cabinet with power supply and cables. See the back pages of BYTE for advertisements.

*For your application, I think a single-sided drive is adequate (and cheaper). The amount of data that can be stored on an 8-inch disk in IBM 3740 format is a quarter megabyte. . . .***Steve**

Scratch-built 68000

Dear Steve,

I am trying to build a 68000-based computer from scrap parts, but I need to find a board that I can stuff. The only boards that I have found have either too little memory (I would like at least 128K bytes) or a cassette interface (I want a floppy-disk interface). Is there a kit available from you or anyone else that would fit my needs? Also, could you tell me whether anyone makes a 68000 board for the S-100 bus? Thank you.

Philip Lawrence
Austin, TX

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Educational Microcomputer Systems manufactures a 68000-based single-board computer that may be of interest to you. While it contains only 20K bytes of on-board RAM, it does have two memory-expansion buses that allow up to 256K bytes. It has two serial ports, a 16-bit parallel port, and is software-compatible with the Motorola MEX68KDM board. A bare board and documentation are available for $99.95 from Educational Microcomputer Systems, POB 16115, Irvine, CA 92713-6115, (714) 553-0133. In addition, a recent ad in Computer Shopper *disclosed a 68000-based processor bare board, Multibus-compatible, with documentation, for $69.99. It is available from Unicorn Electronics, 10010 Canoga Ave., Unit B-8, Chatsworth, CA 91311, (213) 341-8833. Also, Digicomp Research Corporation sells a dual-processor system for the S-100 bus. It is based on the 16-bit MC68000 and the 8-bit Z80 central processing units and features software switching between them. Further information can be obtained from Digicomp Research Corporation, Terrace Hill, Ithaca, NY 14850. . . .***Steve***

Biblical Word Processing

Dear Steve,

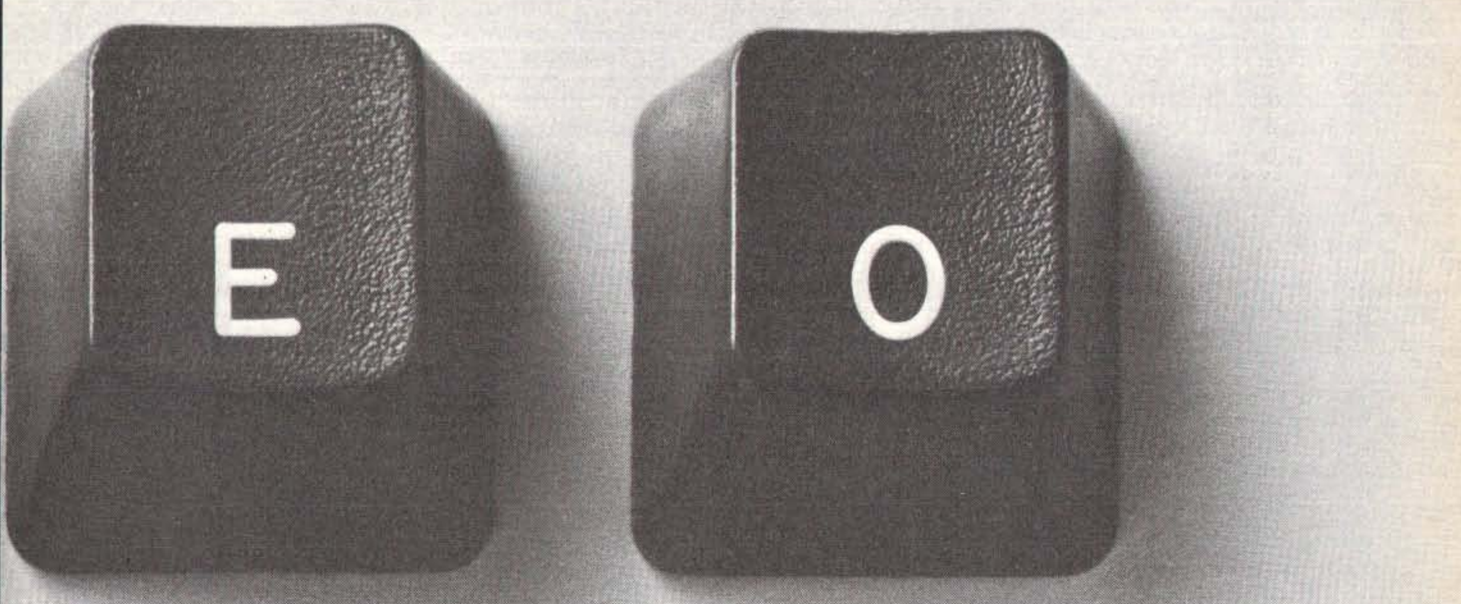
I have an IBM PC and will be purchasing mass-storage equipment as soon as I know what I want to purchase. My need at this point is a program that will permit me to enter thousands of pages of text and then search that text for occurrences of a given word or phrase.

I have approximately 1200 sermons that average 30 pages of text each. Eventually, I want to put all of these in storage. I realize I will need approximately 100 megabytes to accomplish this. Each of these sermons will be named and dated. I would like to be able to put them into the computer in random order but be able to retrieve them in chronological order. After some (or all) of the sermons are in storage, I want to be able to ask the computer to search all (or a designated portion) of the sermons for every occurrence of a certain word or phrase. When an occurrence of the word or phrase is located, I want to be able to preview the context of that word or phrase (with scrolling capability) and then permit either a printout of a chosen portion of the text or an advance to the next occurrence. I would also want to be able to call up any given sermon by name and be able to preview it (again with the printout option). Can you give me any help? Thank you very much.

Donald Derksen
Keystone, SD

Your need to search and retrieve multipage sermons is entirely feasible with your IBM PC. A hard-disk system will be needed, and the software can be as simple as a word processor with "find and replace" capability. Your sermons can be entered as text in pages as they would normally be typed, so that titles, phrases, or any word can be found. The program would have to be compatible with the hard disk.

Unfortunately, I am not aware of such a program. Similar programs do exist and may be adaptable for your use. For example, The Word Processor has the entire King James version of the bible on floppy disks with the ability to search on any word, character, or phrase, with display and print capability. Perhaps the disks can be replaced



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with your sermons. The address is Bible Research Systems, 8804 Wildridge Dr., Austin, TX 78759, (512) 346-2181. Other word-processing programs may have the capabilities that you require. One worth checking is Readiware, POB 680-A, West Redding, CT 06896, (203) 431-3521.

*I think the biggest obstacle to completing your project is the entering of 36,000 pages of text into your computer system. At 5 minutes per page, there is more than 3000 hours of typing required. That's seventy-five 40-hour weeks! . . .***Steve**

More on Modems

Dear Steve,

In regard to your article "Build the ECM-103, an Originate/Answer Modem" (BYTE, March 1983, page 26), the information on modems is invaluable to me. I would like to know if you could reference other publications concerning modems. Thank you.

Christopher J. Rizzo
Staten Island, NY

An excellent article on modems appeared in the November and December 1982 issues of Popular Computing. *The November article, "Modems: Hooking Your Computer to the World" by Stan Miastkowski (page 88), provides a complete description of the terms commonly used with modems and explains the differences between modems. The December article (page 111) describes various software packages that are available. All of your questions should be answered with this information. . . .***Steve**

Synthesizing Sounds

Dear Steve,

I recently built the sound-generating circuit you described in the July 1982 BYTE, "Add Programmable Sound Effects to Your Computer," page 60. I've had a good time with the programs you presented and even wrote a program to produce a siren sound.

Now I'm interested in knowing more about sound synthesis and things I can do with the SN76489A circuit. Can you recommend any books or other sources of information on sound synthesis or electronic sound effects?

John W. Macrae
Maysville, KY

A two-part article in the December 1980 and January 1981 issues of Microcomputing *entitled "Computer Music the Easy Way" by Steve Marum describes an S-100 interface to a Texas Instruments SN76489A Programmable Sound Generator chip and software to create a sophisticated music editor. This editor will translate music into the digital data necessary for the SN76489A. Back issues can be obtained from* Microcomputing, *80 Pine St., Peterborough, NH 03458.*

An excellent book on sound synthesis is Musical Applications of Microprocessors *by Hal Chamberlain, published by Hayden Book Company Inc., Rochelle Park, NJ. It covers digital microprocessor sound and music synthesis and includes a lot of background information. Some parts get rather technical, but it will serve as an excellent reference for this subject. . . .***Steve**

Light-Pen Connections

Dear Steve,

It's easy to build an inexpensive light pen ($1.50) for Atari, VIC-20, or Commodore 64 computers by using a resistor and a phototransistor. The hard part is finding a DE9 connector to hook it up to the computer—unless you cannibalize a broken joystick. Where can I find a source of new DE9s? Thank you.

Matt Blais
Westtown, PA

A search through the back pages of a recent issue of BYTE revealed at least two sources for the DE9 connectors that are used on the Commodore 64 and VIC-20 computers. They are Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097 and California Digital, POB 3097B, Torrance, CA 90503, (800) 421-5041.

*They are listed along with the RS-232C connectors. The DE9 is simply a 9-pin version of the more popular 25-pin "standard" RS-232C connectors. . . .***Steve**

Data-Bank Catalog

Dear Steve,

I would like to know about all the data banks available, and I understand that there is a book published that has compiled this information. Thanks for your help.

Michael G. McElroy
Norman, OK

An excellent list of data banks appears in The Creative Apple, *edited by Pelczarski and Tate and published by Creative Computing Press, Morristown, NJ 07960. . . .***Steve**

Too Many Queens

Dear Steve,

My computer teacher posed an interesting problem to me. He said that there are 12 setups on a chessboard where eight queens could be placed in such a way that none of the queens threatened each other. The problem is to try to find these setups by representing a chessboard by an 8 by 8 matrix. While the algorithm is fairly simple, using eight nested loops to put all eight queens through every permutation, I find it difficult to implement in Commodore BASIC for my home computer. (The computer in school is a PDP-11 with a Pascal compiler.) I am interested in trying it on my computer and seeing how many hours it takes to find the solutions. (I assume it would take hours, because it took several minutes on the PDP-11.) Any help would be appreciated.

David Alexander
East Meadow, NY

*An article that appeared in the October 1978 BYTE, "Solving the Eight Queens Problem" by Terry Smith (page 122), describes another approach to this problem. The program presented should run in Commodore BASIC, but I do not know how long it will "crunch" before all solutions are printed. He mentions that "there are 92 solutions of which 23 are discrete." . . .***Steve**■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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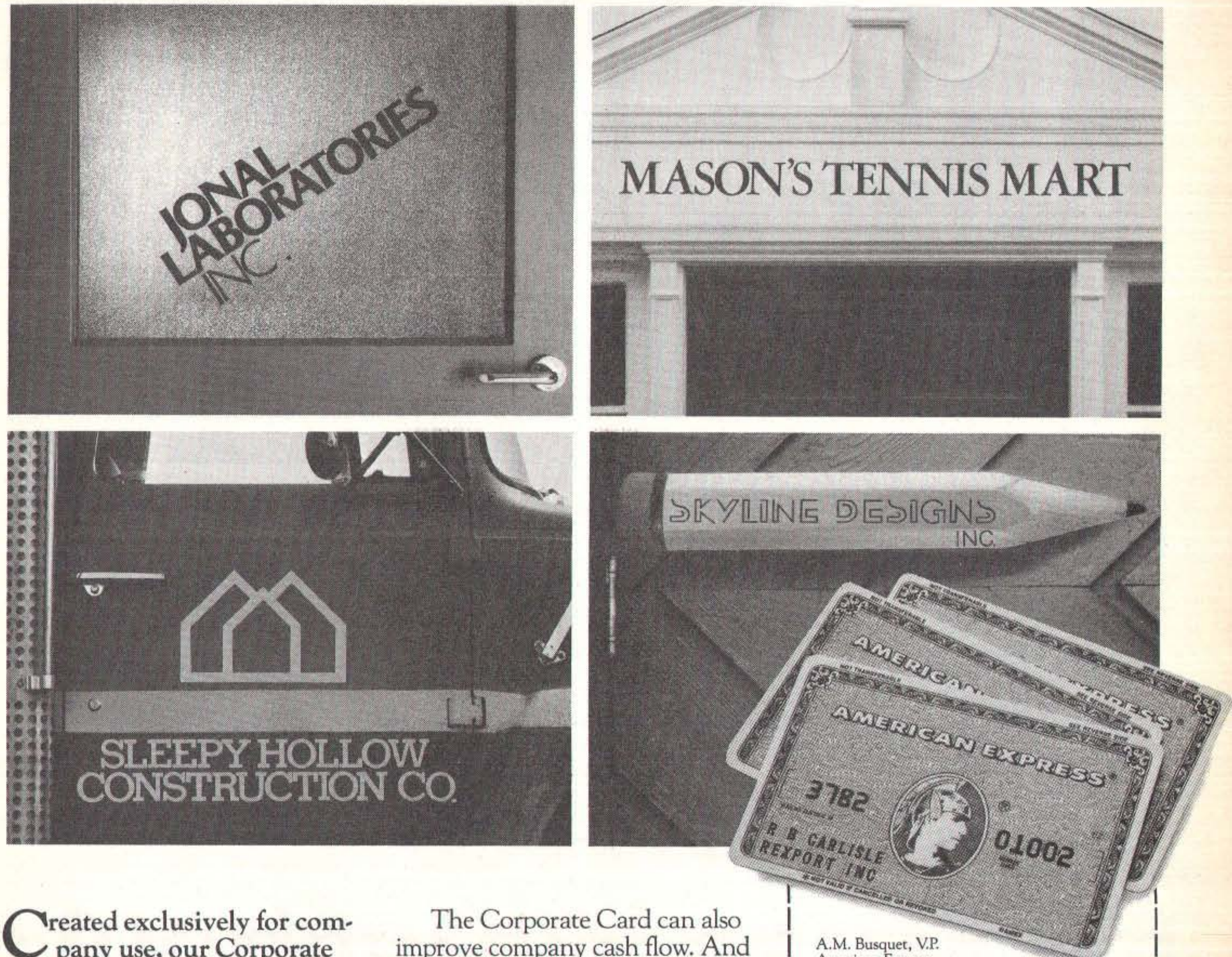

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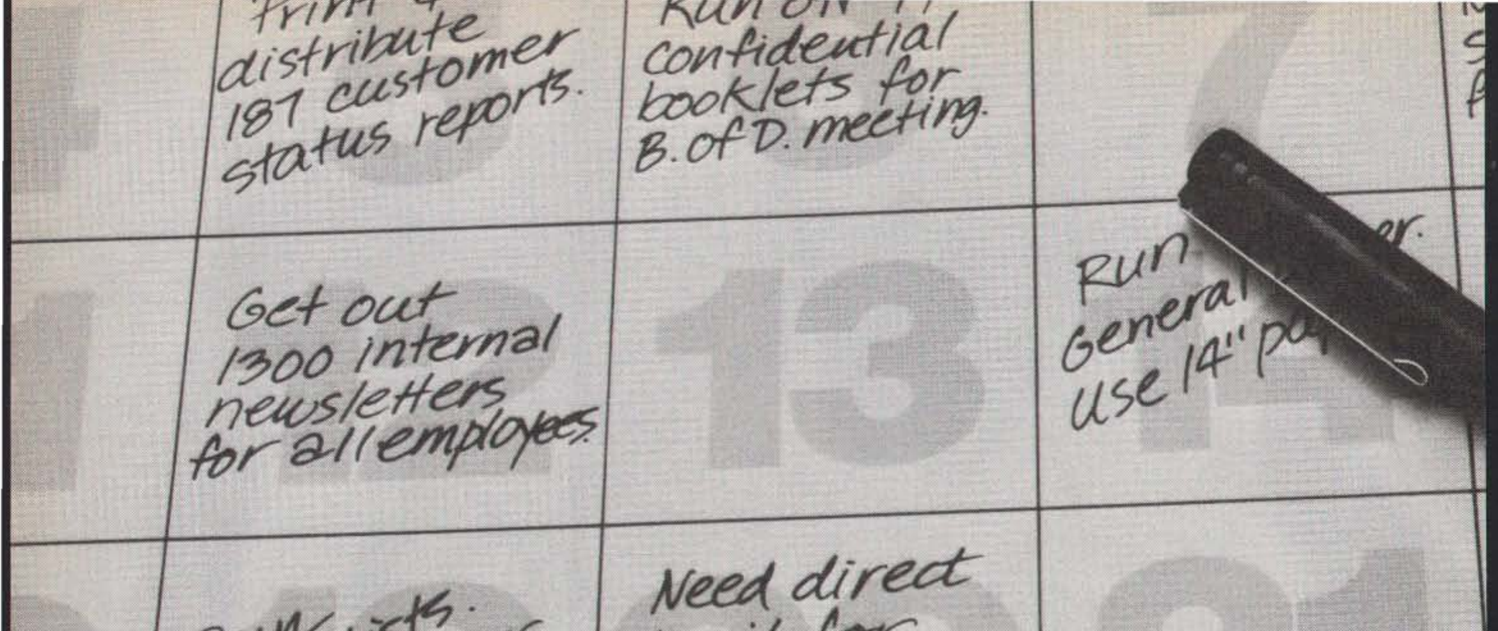

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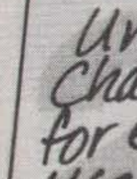

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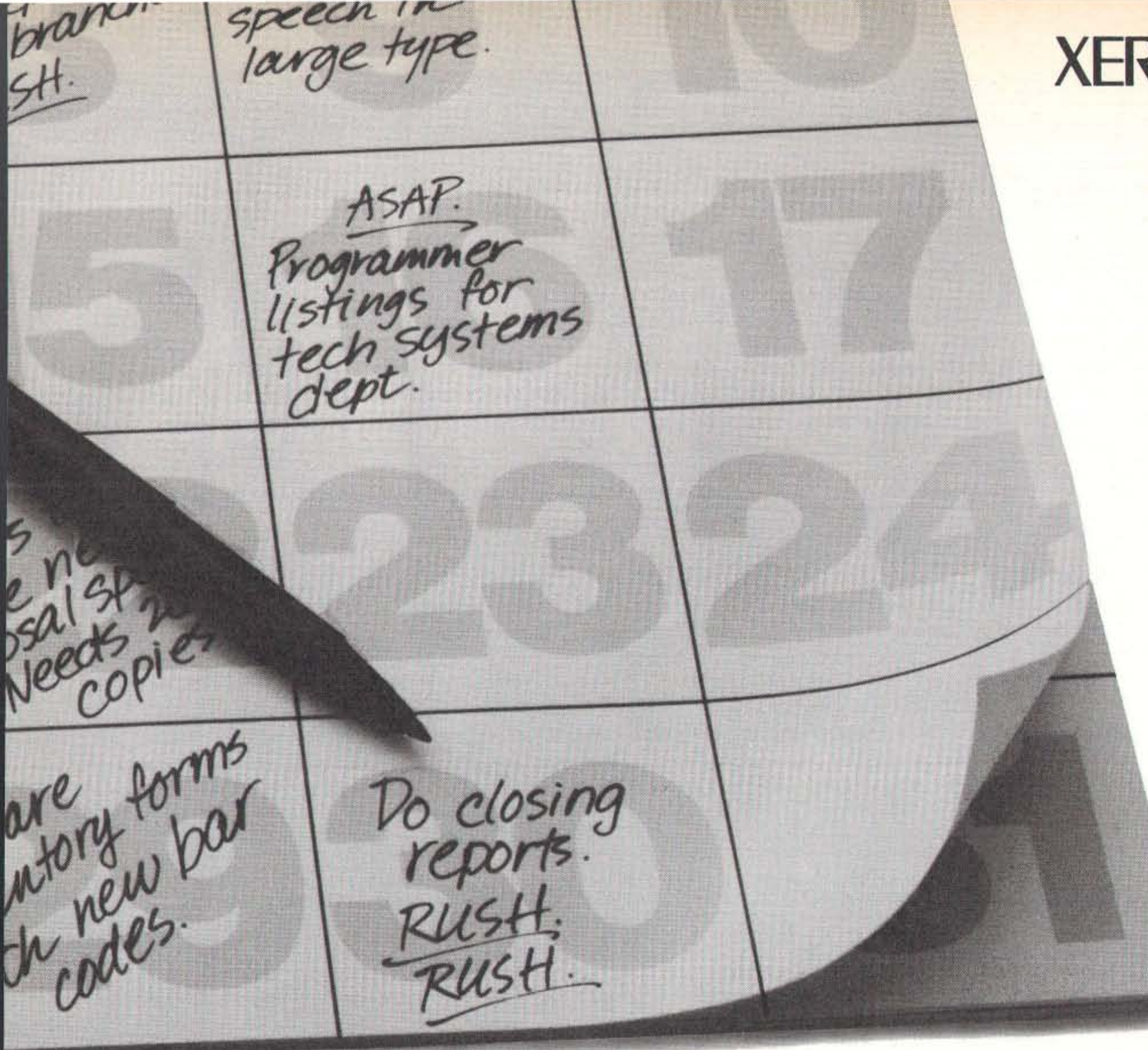

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*This offer is only available through our standard lease plans. It expires on December 31, 1983.

Circle 462 on inquiry card.

Event Queue

December 1983

December

Courses in Continuing Engineering Education, Washington, DC, and San Diego, CA. Two of the five available courses are "Intelligent Robots: The Integration of Microcomputer and Robotic Technology" and "Programming in the C and Unix Environment." Course fees range from $695 to $875. For information on dates, locations, and fees, contact George Harrison, George Washington University, Continuing Engineering Education, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

December

Seminars for Professional Development, various sites throughout the U.S. Datapro Research Corporation offers more than 35 professional development seminars in such areas as personal computers, data communications, systems and software, and office automation. Complete outlines and schedules are available from Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

December-January 1984

Courses from Q. E. D. Information Sciences, various sites throughout the U.S. Scheduled courses include "Systems Analysis Workshop," "Data Security and Design," "Cost-Benefit Analysis," and "Project Management and Control." Address inquiries to Q. E. D. Information Sciences Inc., Q. E. D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

December-January 1984

Intensive Seminars for Professionals, various sites throughout the U.S. *Electronics* magazine, a McGraw-Hill publication, offers seminars in management and the high technology of speech recognition and synthesis, controlling electromagnetic interference, fundamentals of computer graphics, and microprocessor interfacing. In-house presentations can be arranged. For a catalog outlining seminars, locations, and fees, contact Irene Parker, McGraw-Hill Seminar Center, Suite 603, 331 Madison Ave., New York, NY 10017, (212) 687-0243.

December-March 1984

Courses from Integrated Computer Systems, various sites throughout the U.S. A few of the course titles are "Hands-on Unix Workshop," "Designing with 16-bit Micros," "Programming in C—A Hands-on Workshop," and "Hands-on Microprocessor Troubleshooting." The fee for most of the courses is $895. For information, contact Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, Los Angeles, CA 90045, (213) 450-2060.

December-August 1984

Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. and around the world. More than 25 conferences and expositions are scheduled. For a calendar, contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

December 10-12

Computerized Writing Workshops, Gainesville, FL. This workshop is limited to eight writers who are interested in breaking into the word-processing field. For details, write the Press Association, 5305 Northwest 57th Lane, Gainesville, FL 32606.

December 12

The IBM System/36 Seminar, Orlando, FL. This seminar provides a discussion on the capabilities and performance of the IBM System/36. For registration and details, contact DGC Inc., 1450 Preston Forest Square, Dallas, TX 75230, (214) 991-4044.

December 12

Software Workshops in MMSFORTH, Boston metropolitan area. This workshop, "Metaforth and Other Advanced Topics," is a public version of the professional training Miller Microcomputer Services (MMS) offers to client companies in support of the MMSFORTH product line. Details are available from Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760, (617) 653-6136.

December 12-14

An Introduction to Small Computers for Business Applications, Hamilton Hotel, Schaumburg, IL. This conference and hardware demonstration will provide an introduction and review of small computers and microprocessors with an emphasis on what they are, what their terminology is, and what operating systems and software packages are available. Program materials are included in the $350 fee. For details, contact Bob Mattis, Information Systems Division, EECI Inc., POB 241, Glen Ellyn, IL 60137, (312) 790-0010.

December 12-15

Conference on Human Factors in Computing Systems—CHI '83, Boston, MA. Papers, sessions, and tutorials will focus on system usability. The sponsor of this event is the special interest group on Computers and Human Interaction (CHI) of the Association for Computing Machinery (ACM). Further information is available from Raoul N. Smith, GTE Laboratories, 40 Sylvan Rd., Waltham, MA 02254, (617) 466-4044 or 890-8460.

December 13-15

Automatic Testing and Test Instrumentation '83, Metropole Hotel, Brighton, England. This exhibition and conference covers all aspects of test systems. For details, contact Network Events Ltd., Printers Mews, Market Hill, Buckingham, MK18 1JX, England; tel: (028 0) 815226; Telex: 83111.

December 14-15

Hi Tech Update '83, Delta Ottawa Hotel, Ottawa, Ontario, Canada. An annual update on state-of-the-art high technologies. Contact Marg Coll, 1138 Sherman Dr., Ottawa, Ontario K2C 2M4, Canada, (613) 225-4229.

December 15-16

Personal Computer Local Networks, San Francisco, CA. This is the final program in the four-part Architecture Technology Corporation 1983 Forum Series. This program will bring together manufacturers and users of local-network schemes to exchange information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395. For further information, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

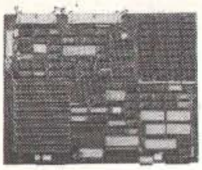
December 27-30

Modern Language Association Convention, Sheraton Centre, New York, NY.

The Micromint Collection

Micromint. Supporting the varied projects that appear in Steve Ciarcia's monthly article in BYTE magazine, "Ciarcia's Circuit Cellar." Offering a wide range of computers and peripherals supporting the needs of the hobbyist as well as worldwide corporate clients.

MPX-16 MICROCOMPUTER IBM PC COMPATIBLE



he MPX-16 is Steve Ciarcia's most ambitious project o date. The computer runs all application software vritten for the IBM PC and is IBM PC bus compatible. Can be used with video monitor & IBM keyboard with optional adapter.

3uy the MPX-16 in the form that best meets your budget. As a bare board, as a wave-soldered board hat contains all components less the IC's, as an ssembled and tested circuit board or as a complete system.

ls featured on the cover of "BYTE" magazine. Also eatured in "Ciarcia's Circuit Cellar" November, December 1982 & January 1983.

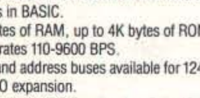
- Runs all application programs written for the IBM PC (simply boot up the system and slip in a disk formatted for the IBM PC).
- IBM PC bus compatible + 9 expansion slots.
- Intel 8088 16-bit microprocessor.
- Optional Intel 8087 math coprocessor.
- 256K bytes on-board memory.
- Up to one megabyte of system memory.
- Up to 64K bytes of system ROM/EPROM.
- Two RS-232C serial I/O ports.
- Three parallel I/O ports.
- Disk controller for 5¼" or 8" drives.
- Sixteen levels of vectored interrupts.

MPX-16 Microcomputer circuit board assembled w/64K RAM, CP/M-86 or PC-DOS BIOS	**$1,200.**
MPX-16 as above with 256K RAM	**1,395.**
MPX-16 Semi-Kit (wave soldered circuit board w/all components) less IC's	**595.**
Complete kit of IC's w/256K RAM	**595.**
MPX-16 Unpopulated (bare) pc board	**300.**
CP/M-86 Operating System	**80.**
MPX-16 Switching Power Supply including cable harness for 2 disk drives	**300.**
MPX-16 Technical Reference Manual	**50.**
MPX-16 Metal Enclosure with cutouts for two 5¼" full height drives	**300.**
Tandon TM 100-2 double density drive	**300.**
IBM PC Keyboard Interface Adapter	**100.**
Serial terminal cable	**35.**
Parallel printer cable	**35.**

Shipping and handling additional on MPX-16 orders.

Z8 BASIC SYSTEM CONTROLLER NEW!!!

eplaces Z8 Basic Computer/Controller



As featured in Ciarcia's Circuit Cellar, BYTE magazine, July & August 1981.

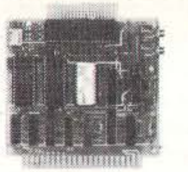
- Uses Zilog Z8671 single chip microcomputer.
- On board tiny BASIC interpreter.
- 2 parallel ports plus serial I/O port.
- Just connect a CRT terminal and write control programs in BASIC.
- 2K bytes of RAM, up to 4K bytes of ROM.
- Baud rates 110-9600 BPS.
- Data and address buses available for 124K memory and I/O expansion.
- Consumes only 1.5 watts at +5, +12 & −12.
- Cross Assemblers for various computers.

BCC11 Assembled & Tested	**$149.**

New Low Price

BM PC is a trademark of International Business Machines, Inc.
CP/M86 is a trademark of Digital Research Inc.
MS-DOS is a trademark of Microsoft Inc.
Z8 is a trademark of Zilog Inc.

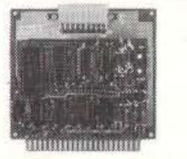
Z8 MEMORY, I/O EXPANSION, CASSETTE INTERFACE



- Add up to 8K of memory plus 3 parallel ports.
- Cassette Interface—300 baud K.C. Standard.

BCC03 w/4K Assembled & Tested	**$149.**

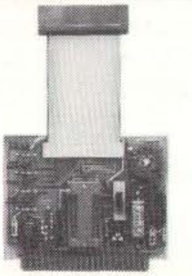
Z8 ANALOG TO DIGITAL CONVERTER NEW!!!



- Uses Analog Devices 7581 8 channel 8 bit IC.
- Adds Process Control capability to the Z8.
- 1000 samples per second.

BCC13 Assembled & Tested	**$140.**

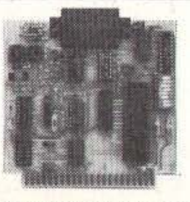
Z8 EPROM PROGRAMMER



- Transfer BASIC or Assembly Language application programs from RAM to 2716 or 2732 EPROM.
- Requires Z8 Expansion Board for operation.

BCC07 Assembled & Tested	**$145.**

Z8 SERIAL EXPANSION BOARD



- Adds additional RS 232C and opto-isolated 20 ma current loop serial port to the Z8.
- Runs at 75 to 19,200 baud in all protocols.

BCC08 Assembled & Tested	**$160.**

Z8 16K MEMORY EXPANSION BOARD NEW!!!

- Add 16K of additional memory, RAM or EPROM, to your Z8 System Controller in any multiple.
- Uses 2016, 6116, 2716 or 2732 memory types.

BCC14 w/8K Assembled & Tested	**$120.**

Z8 FIVE SLOT MOTHER BOARD

MB02 Assembled & Tested	**$69.**

Z8 CROSS ASSEMBLERS

From Allen Ashley

TRS-80 Model I or III	**$75.**
CP/M 2.2 8" or Northstar 5¼"	**150.**

From Micro Resources

CP/M 2.2 8" or APPLE 5¼"	**75.**

SPEECH SYNTHESIZERS

MICROVOX TEXT-TO-SPEECH SYNTHESIZER

As featured in Ciarcia's Circuit Cellar BYTE Magazine September, October 1982.

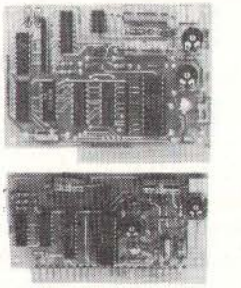
Microvox is a second generation professional voice quality text-to-speech synthesizer that is easily interfaced to any computer, modem, RS-232C serial or parallel output device and provides speech of unbelievable clarity.

- Unlimited vocabulary.
- 64 programmable inflection levels.
- 6K text-to-speech algorithm.
- Full ASCII character set recognition and echo.
- RS232C and parallel output.
- 1000 character buffer, 3000 optional.
- Adjustable baud rates (75-9600).
- Spelling output mode.
- 7 octave music and sound effects.
- On board audio amplifier & power supply.
- X-On/X-Off handshaking.

MV01 Assembled with 1K buffer	**$299.**
MV02 Complete Kit with 1K buffer	**219.**

Add $15.00 for 3K buffer option.

SWEET-TALKER VOICE SYNTHESIZER



As featured in Ciarcia's Circuit Cellar BYTE Magazine, September 1981

The Sweet-Talker Voice Synthesizer allows you to add speech of unlimited vocabulary to your Apple II or any computer with a parallel printer port at very low cost.

- Utilizes Votrax SC-01A speech synthesizer.
- Unlimited vocabulary.
- Text-to-Speech Algorithm on disk for Apple II.
- Contains 64 phonemes accessed by 6-bit code.
- Four levels of programmable inflection.
- On board audio amplifier & volume control.

ST02 Apple II plug-in, Assembled & Tested with Text-to-Speech Algorithm on 3.3 disk	**$99.**
NEW LOW PRICE!!!	
ST01 Parallel Port Version, Assembled	**99.**

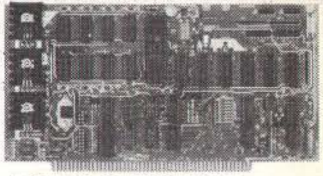
New Low Price

VOTRAX SC-01A PHONETIC SPEECH SYNTHESIZER

The SC-01A Speech Synthesizer is a completely self-contained solid state device that phonetically synthesizes continuous speech of unlimited vocabulary. Used in Microvox and Sweet-Talker.

SC01A Quantity 1-99	**$44. ea.**
100 +	**32. ea.**
1000 +	**24. ea.**

E-Z COLOR GRAPHICS INTERFACE



As featured in Ciarcia's Circuit Cellar BYTE Magazine, August 1982

Add color graphics, animation & 3-D effects to your S-100, TRS-80 Model I and III & Apple II at low cost. The Super Editor software package includes a pattern editor, sprite editor, slide show, and demo scenes all in BASIC. Can be used with Color Monitor or TV set and rf modulator.

- Resolution—256 X 192 Pixels.
- 16 colors including Black & Transparent.
- 16K Bytes on board I/O mapped video memory.
- Advanced TI TMS9918A Color Video Processor.
- 32 SPRITES facilitates 3-D effect.
- Composite Video output.
- Krell & Terrapin have LOGO software packages to support the E-Z Color Boards.

Apple II E-Z Color plug-in board with Super Editor on 3.3 disk.

EZ01 Assembled & Tested	**$119.**
EZ02 Complete Kit	**105.**

NEW!! S-100 E-Z Color Graphics board with sound generator, Atari type joy stick interface, plus MBasic CP/M Super Editor Software on 8" disk.

EZ04 Assembled & Tested	**$289.**

TRS-80 Model I or Model III E-Z Color w/ Super Editor software, power supply and enclosure.

Assembled & Tested	**$249.**
Complete Kit	**219.**

300 BAUD ANSWER/ORIGINATE MODEM KIT NEW!!!

As featured in Ciarcia's Circuit Cellar BYTE Magazine, March 1983

The newest item to Micromint's growing list of products is this 300 Baud Modem. It is crystal controlled, uses the TI TMS 99532 IC, contains just 25 parts and can be used with an acoustic coupler or in a direct connect mode.

MD04 Complete Kit	**$60.**
MD05 Transformer for Direct Connect Mode	**9.**
AC01 Acoustic Coupler Kit	**$20.**

TRIPLE VOLTAGE POWER SUPPLIES

+5v @ 300 ma. +/− 12v @ 25 ma.

UPS01 Assembled & Tested	**$35.**
UPS02 Complete Kit	**27.**

+5v @ 1 Amp. + 12v @ .5 Amp. − 12v @ 50 ma.

UPS03 Assembled & Tested	**60.**
UPS04 Complete Kit	**50.**

MICROMINT INC. *561 Willow Avenue,*
Cedarhurst, NY 11516
To Order: *Call Toll Free 1-800-645-3479*
For Information Call: *1-516-374-6793*
Call: Monday-Friday, 9-5 PM

Circle 289 on inquiry card.

Among the highlights of this convention is a large technology exhibit. Full details are available from the Modern Language Association of America, 62 Fifth Ave., New York, NY 10011, (212) 741-5587.

January 1984

January-February

Fundamentals of Finance and Accounting Using a Microcomputer, various sites throughout the U.S. This three-day seminar is sponsored by the Data Processing Institute of the New York University School of Continuing Education. It will cover microcomputer applications for effective decision making and controlling business requirements. Previous computer knowledge is not required. The fee for the course is $695. For specific dates and locations, contact the NYU School of Continuing Education Seminar Center, 575 Madison Ave., New York, NY 10022, (212) 748-5094.

January 2-6

Microcomputer Applications for Executives and Professionals: An Introductory Hands-on Approach, Limetree Beach Hotel, St. Thomas, Virgin Islands. Applications, word processing, spreadsheets, data management, and integrated software packages are a few of the topics to be presented at this seminar. Depending on enrollment, one or two people will share IBM Personal Computers using Lotus's 1-2-3 spreadsheet and other selected software. For further details, contact Dave Olson, Computer Workshops and Seminars Inc., 6th floor, 1701 Arch St., Philadelphia, PA 19103, (215) 496-0323.

January 4-6

Seventeenth Hawaii International Conference on System Sciences, Honolulu, HI. This conference is devoted to advances in information and system sciences with emphasis on medical-information processing, decision-support systems, and office automation. For information, contact Emily Yano Jorgensen, Center for Executive Development, College of Business Administration, University of Hawaii, 2404 Maile Way C-202, Honolulu, HI 96822, (808) 948-7396.

January 4-8

The Third American Society of Computers in Medicine and Dentistry Conference, Sheraton Waikiki Hotel, Waikiki, HI. The intention of this forum is to promote the clinical uses of microcomputers in medical, dental, and veterinary practices. The cosponsor of this event is the Ohio State University Department of Anesthesia. For further details, contact Arlene Rogers, American Society of Computers in Medicine and Dentistry, POB 21483, Upper Arlington, OH 43221, (614) 421-8487.

January 8-11

Retail Directions '84, New York Hilton and Sheraton Centre Hotels, New York, NY. The 73rd annual convention and exposition sponsored by the National Retail Merchants Association (NRMA) will feature new developments in retail store technology, business systems, marketing techniques, and sales-promotion tools. Admission is free to bona fide members of the retail industry. For details, contact Dan Soskin, NRMA Enterprises, 100 West 31st St., New York, NY 10001, (212) 244-8780.

January 8-14

CADRE '84 Conference and Teachers Institute, San Jose, CA. Computers in Art and Design, Research and Education (CADRE) is a forum that brings together leaders, thinkers, and computerists from all walks of life to explore the impact of computers on the arts. The Teachers Institute begins on January 11. Its fee is $100. Registration for the conference is $200 or $250 on site. For details, contact CADRE '84 Conference, Department of Art, San Jose State University, Washington Square, San Jose, CA 95192, (408) 277-2555.

January 9-13

Technology Opportunity Conference, Houston, TX. This conference focuses on the convergence of optical-storage, videodisk, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1133.

January 14-15

The Fourth Annual Computer Fair, Northland Mall, Sterling, IL. This event is sponsored by the Sauk Valley Computer Club. For details, contact Vinus Williams, Rt. 1, Milledgeville, IL 61051, (815) 625-8585 days.

January 16-17

MOS Analog/Digital Interface Circuit Design for VLSI Systems, San Francisco Airport Hilton Hotel, San Francisco, CA. This short course will emphasize applicable design techniques for very large-scale integration systems. Course notes are included in the $450 fee. For a brochure, contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

January 17-19

Mini/Micro-Southeast and **Southcon/84 High Technology Electronics Exhibition and Convention**, Orange County Convention/Civic Center, Orlando, FL. Mini/Micro, designed for the original equipment manufacturing community, explores peripherals, processors, data communications, and software. A few of the topics to be addressed at Southcon/84 are artificial intelligence, computer-aided design, and factory automation. For details on these concurrent events, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

January 17-20

Uniforum, Washington Hilton, Washington, DC. This conference and exposition is designed for and by users of Unix-based systems. For details, contact Mark Weber, Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon Ave., Des Plaines, IL 60018, (800) 323-5155; in Illinois, (312) 299-3131.

January 18-23

Commtex International and **NAVA/ICIA '84 Convention**, Dallas Convention Center, Dallas, TX. This communications and information technologies exposition highlights the latest developments in audio-visual, video, and microcomputer products for many communication needs. The concurrent convention is sponsored by the National Audio Visual Association/International Communications Industries Association (NAVA/ICIA). For information, contact Robert Milko, NAVA, 3150 Spring St., Fairfax, VA 22031, (703) 273-7200.

January 23-25

Teaching Math with Microcomputers, Hacienda Resort Hotel, Las Vegas, NV. This seminar, sponsored by the National Council of Teachers of Mathematics (NCTM), is designed to inform educators

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IT GIVES YOU A RECORD OF YOUR CHARGES IN WELL UNDER A MINUTE.

See how fast you can return your car.

You'll never have to go to the rental counter again to return your car and get a record of your rental expense. Because we give you something no one else can. Avis Rapid Return.℠ The first–and only–fully automated, self-service car return system in car rental history!

And Rapid Return is as easy to use as your pocket calculator. Just punch in your car number, mileage and gas gauge reading. In well under a minute it not only completes your car return; it also gives you a copy of your rental charges.

And since you get your charges so quickly you'll be able to complete your expense account quickly, too.

"I get a copy of my expenses without waiting at the rental counter!"

NO LINES. NO WAITING. NO COMPETITION.

The simple fact is that the competition just isn't fast enough to beat Rapid Return. And it's been proving itself at some of the busiest airports and downtown locations for the past several months.

As a result, whenever you run to use new Rapid Return, you won't run into a line to slow you down. And all you need to use Rapid Return is an Avis or another major credit card.

So if you want to return your car and get a copy of your rental charges the fastest way possible, there's just one place to go, Avis. Because only Avis offers the technological leadership that delivers state of the art services like Rapid Return. It's designed to make car renting faster and easier than ever for you.

It's easy to use as your pocket calculator!

Avis features GM cars. Chevrolet Caprice Classic.

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in elementary, intermediate, and secondary schools about using microcomputers effectively in mathematics education. For details, contact NCTM Seminar Series, 1906 Association Dr., Reston, VA 22091, (703) 620-9840.

January 24-26

Advanced Semiconductor Equipment Exposition (ASEE) and **Technical Conference,** Convention Center, San Jose, CA. Five sessions designed as a broad-based program focus on the manufacturing aspect of the semiconductor industry. For details, contact Joyce Estill, Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

January 25-27

The Business Telecommunications Exposition, Stadium Club, Giants Stadium, East Rutherford, NJ. This exposition is designed for managers in the fields of telecommunications, facsimile communications, and communications in voice, video, and data. Other topics to be covered are office automation, word processing, and purchasing. Registration is required for admittance to the exposition. Contact Michael Houston, The Exposition Group Inc., 9128 Columbia Ave., North Bergen, NJ 07047, (201) 662-1318.

January 27-29

Resource '84, Shamrock Hilton Hotel, Houston, TX. This computer exposition is dedicated to users in the medical, dental, legal, and accounting professions who need to buy a new system or want to upgrade existing systems. Telecommunications information and software applicable to home and office uses will be displayed. Admission is free for physicians, dentists, attorneys, and accountants; all others pay $2.50. Entrance to any or all of the seminars is $10. For details, contact Joyce Fadem, Professional Resources Inc., POB 740433, Houston, TX 77274.

January 31-February 3

The Sixth Annual Communication Networks 1984 Conference and Exposition, Washington Convention Center, Washington, DC. Voice and telecommunications, electronic mail, data processing, and communications are a few of the products and services to be displayed at this event. Registration information is available from Louise Myerow, POB 880, Framingham, MA 01701, (800) 225-4698; in Massachusetts, (617) 879-0700.

February 1984

February 2-4

The Third Annual SCS Multiconference, Bahia Hotel, Mission Bay, San Diego, CA. This conference, sponsored by the Society for Computer Simulation (SCS), is composed of four conferences: Modeling and Simulation on Microcomputers, Simulation in Health Care Delivery Systems, Aerospace Simulation, and Simulation in Strongly Typed Languages, Ada, Pascal, Simula. For details, contact Gloria Rico, SCS, POB 2228, La Jolla, CA 92038, (619) 459-3888.

February 7-9

Florida Agribusiness Computer Conference and Trade Show, Civic Center, Lakeland, FL. This conference will demonstrate how computers can be used as decision-making tools for managers in agribusiness. The sponsor of this second annual farm computer conference is the University of Florida's Institute of Food and Agricultural Sciences (IFAS). For details, contact IFAS Director of Conferences, 1041 McCarty Hall, University of Florida, Gainesville, FL 32611, (904) 392-5930.

February 13-16

Kuwait Info '84, International Exhibition Center, Kuwait City, Kuwait. Exhibits in this third annual event will encompass a broad range of information businesses, including data processing, word processing, communications, office automation, micrographics, security systems, and environmental control systems. Information is available from Carol Purdey, Intermarket Network Corp., Suite 203, 1110 Vermont Ave. NW, Washington, DC 20005, (202) 822-0127.

February 13-16

ACM Computer Science Conference, Franklin Plaza Hotel, Philadelphia, PA. This conference is sponsored by the Association for Computing Machinery (ACM) and the computer science departments of many universities. For details about the Twelfth Annual Employment Register, which is a highlight of the conference, contact the ACM Computer Science Employment Register, Department of Computer Science, University of Pittsburgh, Pittsburgh, PA 15260. For details about the ACM Computer Science Conference, contact the Association for Computing Machinery, 1133 Avenue of the Americas, New York, NY 10036, (212) 265-6300.

February 20-22

1984 Office Automation Conference (OAC '84), Los Angeles Convention Center, Los Angeles, CA. The fifth annual OAC, sponsored by the American Federation of Information Processing Societies (AFIPS), will feature five tracks oriented toward the interests of managers and administrators; technology managers and planners; analysts, consultants, and implementors; product designers and developers; and users of the automated office. For information, contact AFIPS Inc., 1815 North Lynn St., Arlington, VA 22209, (703) 558-3617.

February 20-23

APAC '84, Inter-Continental Hotel, Riyadh, Saudi Arabia. Arabian Productivity Advancement Using Computers/Graphics (APAC) is the first international conference and exposition on computer graphics to be held in Saudi Arabia. Industry and government representatives from Middle Eastern and Western nations will attend. For information, contact APAC '84 Conference Director, World Computer Graphics Association Inc., Suite 399, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

February 21-23

Softcon, Superdome, New Orleans, LA. This international software conference and trade fair is designed for retailers, independent sales organizations, consultants, government agencies, educational institutions, and professional software developers. Registration is $15. For further information, contact Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

February 22-28

Imprinta 84, Fairgrounds, Dusseldorf, West Germany. This international congress and exhibition will feature techniques and services in print communication and its alternatives. For details, contact Dusseldorf Trade Shows, 500 Fifth Ave., New York, NY 10110, (212) 840-7744. ■

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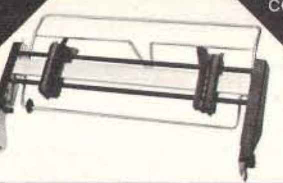
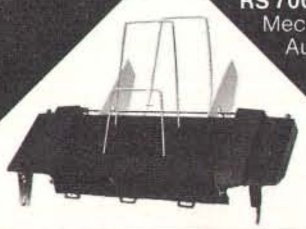
Portrait and landscape forms – Models for most letter quality printers – With or without interfaces – Electronically or mechanically controlled – No operator adjustments required – No reverse platen motion required – High precision registration – UL-recognitions – Multi-part forms – No paper cassettes – Field proven – Envelope attachment – Any paper size up to 12″ x 15″ – Clip-on mounting – Complete control of paper and its pathway to print-mechanism! – Lightweight – The Single Bin Cut Sheet Feeder most in use – Swiss-made quality

RT 200
Bi-directional Forms-Tractor. For precise continuous form feeding.


RT 200

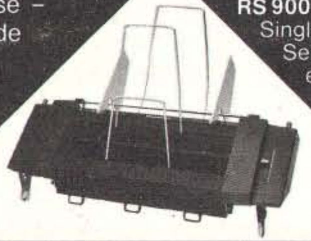
RS 700
Mechanical Sheet Feeder. Automatic feeder with mechanical control mechanism. No electronics required. Driven forward by printer platen.


RS 700

RS 800
Demand Sheet Feeder. Feeds sheets on command from an external interface. Compatible with RS 950.

RS 800

RS 900
Single Bin Sheet Feeder. Self-controlled automatic feeder with internal electronics for universal application. The most widely used single bin feeder in the world.


RS 900

RS 950/RS 1950 Double Bin Sheet Feeder. Feeds sheets from either of two supply bins upon command from an external interface. Direct control by printer electronics. OEM supplied interface or custom interface available for selected printers.

RS 950

Rutishauser Products are available for a wide variety of popular types of Letter Quality Printers.

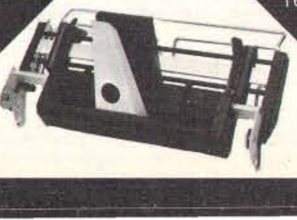
AES · Anadex · Binder · Brother · Centronics · Daisy Systems · Diablo · Data-Royal · Dataproducts · Facit · Fujitsu · HPI · IBM-System 6 · Mannesmann Tally · NEC · Olympia · Qume · Ricoh · T.A. · Santec · SCM · TEC/C. Itoh · Toshiba · Walther · Wang · Xerox

Maybe you didn't know we offer such a large Family of Devices!

RS 1000/RS 1100
Programmable Double Bin Sheet Feeder. Independent self-controlled feeding from two supply bins, with or without external electronic commands. Several modes of operation including user programmable sheet selection and programmed platen motion sheet selection. Feeds sheets up to 12″ wide.

RS 1000

RF 400 Front Feed Device. Programmed insertion of single or multipart forms for precisely registered applications – preprinted forms, ledger cards, etc.


RF 400

Rutishauser

Rutishauser Data AG, Rhynerstrasse 9, 8712 Stäfa, Switzerland
Tel. (01) 926 43 00, Tx. 875171 ruti ch
Rutishauser of America, Inc., 9677 Wendell Road, Dallas, TX 75243, U.S.A.,
Tel. (214) 3439154, Tx. 730609 ruti dal – a subsidiary of Rutishauser Data AG

Circle 496 on inquiry card.

What's New?

HOLIDAY COMPUTING

Collector Plate Shows Santa Computing

A limited edition collector plate called **Santa's Computer** is available from American Artists. The plate, executed in a fashion similar to the late Norman Rockwell, depicts Santa at a computer console entering requests from good children as his faithful elves scurry about sorting letters and preparing lists for his calculations.

This 8½-inch fine china plate was created by Scott Gustafson, a Chicago-based illustrator. Gustafson has illustrated a number of publications and children's books and has worked as an artist for the **Saturday Evening Post**. The issue price for this collectible is $29.50. For more information, contact American Artists, Fourth Floor, 225 West Hubbard, Chicago, IL 60610, (312) 828-0555.

Circle 603 on inquiry card.

Tab-feed Greeting Cards

Seasonal greeting cards with continuous tab feed and clean-edge perforations have been introduced by Compucards. The inside of the card is blank so that you can print your personal holiday greetings. Complementary envelopes are provided.

Presently, Compucards offers a choice of Christmas cards. The first features Mrs. Claus adjusting her husband's scarf; the second depicts four jolly revelers arriving in their horse-drawn sleigh. Both cards are rendered in red and black inks. A package of 20 cards with envelopes is $9.95. For details, contact Compucards, POB 894, Stone Mountain, GA 30086.

Computer Board Game for Children

Computer Caper is a computer-literacy board game for children ages 4 to 8. It comes with stickers and a computer riddle book. To win, you must be the first player to move your computer chip from Input Island to Printout Pass. Two to four players can participate. Computer Caper is available for $10, postage paid, from Holiday Games Inc., 5501 West North Ave., Milwaukee, WI 53208, (414) 444-1060.

Circle 607 on inquiry card.

Home Learning Entertainment System

Chalk Board's Powerpad, a touch-sensitive input device, and Leonardo's Library of software packages form an integrated learning/entertainment system. The Powerpad is a 17- by 20-inch hard plastic case housing a 12- by 12-inch touch-sensitive tablet that effectively replaces your computer keyboard. Powerpad uses a form of membrane-switch technology that has thousands of digital switches that register multiple points of contact simultaneously.

A Mylar overlay that fits the Powerpad work area is supplied with each package in Leonardo's Library. The overlay, when used with its accompanying cartridge or disk software, works with the Powerpad to provide a range of interactive applications, such as an artist's canvas or a piano keyboard. Six subject areas make up Leonardo's Library: language arts, mathematics, music, science, social studies, and visual arts. A Logo package and a programming kit are among the programs offered.

The Powerpad and Leonardo's Library run on such home computers as the Apple II, II Plus, and IIe, Atari 400/800, Commodore VIC-20 and 64, and the IBM PC and PC/XT. Powerpad costs $99.95. Software packages range from $24.95 to $49.95. For further information, contact Chalk Board Inc., 3772 Pleasantdale Rd., Atlanta, GA 30340, (800) 241-3989; in Georgia, (404) 496-0101.

Circle 604 on inquiry card.

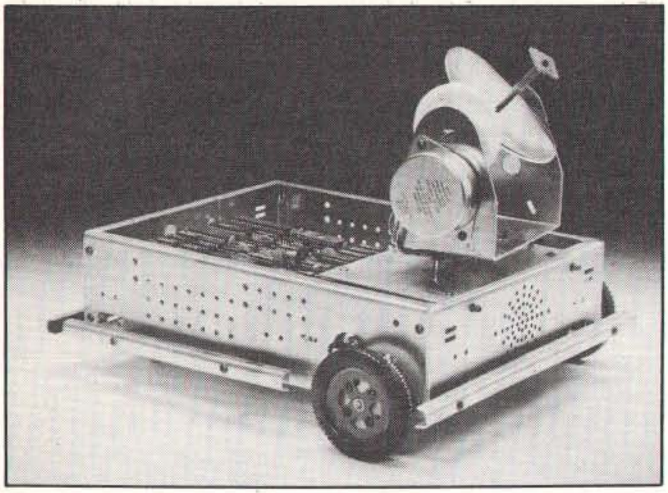
Computer Widow T-Shirts

Purple-on-lavender T-shirts and nightshirts bearing the lament "Computer Widow" are available from JMK Computer Services. T-shirts cost $7.95, plus $1.25 shipping. The nightshirts are $12.95, with $1.50 postage. Contact JMK Computer Services, POB 1672, West Caldwell, NJ 07007, (201) 227-3348.

Circle 602 on inquiry card.

Low-cost Robot Beeps and Barrels Along

Rhino Robots' Scorpion is a compact, software-programmable robot that makes noises as it trundles along your floor.



Scorpion's base measures 9 by 12 inches and resembles NASA's Lunar Landing Module. With it, you can devise your own artificial-intelligence experiments while spending less than $700.

Scorpion is equipped with a 6502 microprocessor, an 8K-byte EPROM, 2K bytes of RAM, and two 6522 interface chips that provide 32 I/O lines and four programmable timers, two of which can be event counters. Its eight microswitches discern obstacles in its path and provide the means for avoiding those obstacles when retracing a preset path. A two-axis optical scanner with a resolution of 1.5 degrees of scan per step recognizes patterns over a 300-degree span in both vertical and horizontal planes. Visual patterns can be displayed on your computer's video monitor. Additional hardware includes sensing bumpers, a speaker, two ground tracks, two "eyes," and four motors, two of which are drive wheels.

Scorpion works with any computer with an RS-232C interface. It operates from a 12-V DC power supply. Shipped in kit form with complete assembly and programming instructions, Scorpion costs $660. For more information, contact Rhino Robots Inc., POB 4010, Champaign, IL 61820, (217) 352-8485.

Circle 601 on inquiry card.

Bumper Sticker for Hackers

Surprise the computer hacker in your life with the "I Love My Computer" bumper sticker from International Computer Products. Printed on a durable white plastic base, this bumper sticker features the customary red heart to express affection. As an added attraction, a pair of red lips replaces the "o" in "Computer." For each copy, send $1.50, plus $0.20 shipping, to International Computer Products, 346 North Western Ave., Los Angeles, CA 90004.

Circle 600 on inquiry card.

Computer Tie

Tie-One-On is marketing a holiday gift for those hard-to-buy-for males: the computer tie. Woven into this navy blue tie are the words bit, byte, floppy, hard, RAM, ROM, micro, and mini. The tie is made of a silk/polyester blend and is available for $15.95, postage paid, from Tie-One-On Inc., POB 40225, Philadelphia, PA 19106, (215) 625-2855.

Circle 605 on inquiry card.

SYSTEMS

NS16032-based Megamicro Runs Unity

The Megamicro LMC-16032, a 32-bit, virtual-memory microcomputer based on National Semiconductor's NS16032 microprocessor and running under Human Computing Resources' Toronto Unity operating system, has been introduced by the Logical Microcomputer Company. The LMC-16032, which operates on the IEEE-796 (Multibus) standard, provides demand-paged address and data space of up to 16 megabytes for each of its 32 possible users. It can perform 161,000 double-precision, 64-bit floating-point multiplications per second. The LMC-16032 can handle 16 hard-disk drives for a total memory capacity of more than 1600 megabytes.

In its basic configuration, the LMC-16032 comes with virtual memory, floating-point hardware, 512K bytes of parity checking RAM, eight serial RS-232C ports, an intelligent disk controller, and a 20-megabyte Winchester hard-disk drive. Toronto Unity, an implementation of Berkeley's 4.1 enhancement of Bell Laboratories' Unix operating system, serves as the DOS, and C and FORTRAN compilers are supplied. Fully assembled and tested, the basic system costs $15,000. An enclosure and all manuals, cables, and power supplies are provided.

Such optional hardware as error-correcting RAM, additional serial and parallel ports, and 16-, 20-, and 40-megabyte hard-disk drives can be ordered. Optional languages include Pascal, PL/I, COBOL, Ada, and LISP. For further information, contact the Logical Microcomputer Co., 140 South Dearborn St., Chicago, IL 60603, (312) 580-0250.

Circle 617 on inquiry card.

What's New?

Computer-aided Drafting System for Architects

Bausch & Lomb has introduced a computer-aided drafting system for architects. Called Prodraft, this system has a 15-inch high-resolution (1024 by 800) raster-graphics display and an MC68000 processor. A menu tablet lets the operator quickly select repetitive figures and functions, and the 6.7-megabyte Winchester hard-disk drive is accompanied by a single-sheet, A-to-D size plotter. Special menus include residential, commercial, light commercial, and renovation packages.

An Architectural Drafting Library composed of more than 100 predrawn figures and symbols is available. Prior computer experience is not required because Prodraft comes with a training manual and videotaped instructions. Prodraft sells for $29,995. Contact Bausch & Lomb, Interactive Graphics, POB 14547, Austin, TX 78761, (512) 837-8952.

Circle 609 on inquiry card.

Single-board Computer Is CP/M-compatible

The single-board EQ-4 from Insight Enterprises is compatible with CP/M 2.2 and 3.0. It has virtual memory-mapping circuitry that lets the Z80A central processor and the DMA controller directly access 128K bytes of RAM, 2K bytes of EPROM, and 4K bytes of video memory in 8K-byte blocks.

Interfaces incorporated into the EQ-4 include SASI, four serial RS-232C channels with independently programmable data rates ranging from 110 to 76,800 bps, a Centronics parallel printer, and floppy-disk ports. The floppy-disk controllers can handle single- and double-density 5¼- and 8-inch drives simultaneously. CTC, DART, and PIO peripheral controllers are standard. The parallel keyboard input accommodates 7- or 8-bit ASCII-encoded boards with jumper-selectable active high and low strobes. Horizontal and vertical sync signals and composite video output compose EQ-4's video features. Standard Microsystems' 8002 video-display attributes controller provides the EQ-4 with an on-chip character generator, 128 characters in a 7- by 11-dot matrix, and character-oriented, wide- and thin-line graphics. Attributes supported for each character are reverse video, character blank, blink, underline, and strike-through.

The single-unit price for the EQ-4 is $750, which includes CBIOS, utilities, and source codes. Complete specifications are available from Insight Enterprises Corp., Suite 12, 373 North Western Ave., Los Angeles, CA 90004, (213) 461-3262.

Circle 613 on inquiry card.

Line of Micros Marketed at Compushack Stores

A line of IBM PC-compatible computers from Tava Corporation is sold at Compushack stores.

The Tava PC features 64K bytes of RAM, five PC-compatible expansion slots, a parallel printer interface, two serial ports, and a keyboard. The RAM is expandable to 256K bytes, and up to nine expansion slots are possible. It costs $995.

The portable Tava PC 1 is an enhanced version of the Tava PC, offering identical memory, expansion, and interface capabilities. Enhancements include dual slim-line 320K-byte 5¼-inch floppy-disk drives and a 9-inch display. The PC 1 retails for $1995.

The Tava Executive PC (base price, $2995) has built-in network capabilities that can accommodate 16 terminals. Standard hardware includes 256K bytes of RAM, 640K bytes of dual floppy-disk storage, a parallel printer port, and a serial interface. RAM is expandable to 512K bytes.

For complete details, contact your local Compushack outlet or Compushack, Tava Corp., 16861 Armstrong, Irvine, CA 92714, (714) 261-1000.

Circle 616 on inquiry card.

Color Computer Uses 6809E

The Bestcom GTX-1000 color computer, based on the 6809E microprocessor, can be attached to a home color television. The basic GTX-1000 comes with 16K bytes of RAM, 16K bytes of ROM, a built-in modem connector, one cassette and two joystick interface ports, and an RS-232C port. An optional expansion unit has provisions for a parallel printer, additional memory, and floppy- or Winchester-disk drive controllers. The standard operating system is Microsoft Extended BASIC. Contact Graphtek Corp., 2959 West Fairmount Ave., Phoenix, AZ 85017, (602) 277-7434.

Circle 612 on inquiry card.

What's New?

Portable Computer Has Built-in State Analyzers

Omnilogic has unveiled Omni II, a portable CP/M-compatible computer with built-in timing and state logic analyzer capabilities. The 27-pound, software-intensive Omni II can collect 1000 data samples on each of its 16 channels or, as an option, 330 samples per channel on up to 48 channels. For software analysis, up to 16 channels of data recognition are available. All test parameters and data can be stored on a CP/M-based floppy-disk format for additional off-line analysis. Any display can be dumped to a printer.

Omni II's hardware specifications include a Z80 microprocessor, 64K bytes of memory, two double-density 5¼-inch floppy-disk drives, a 9-inch green-phosphor monitor, and RS-232C and Centronics-type parallel ports. It's supplied with such general-purpose software as CP/M-80, Perfect Writer, Perfect Speller, Perfect Filer, Perfect Calc, Profitplan, and S-BASIC.

The Omni II is priced at $3950. Contact Omnilogic Inc., POB 87, Renton, WA 98057, (800) 228-6664; in Washington state, (206) 271-2000.

Circle 610 on inquiry card.

Low-cost Computer Offers High-price Features

Memotech Corporation is marketing a low-cost Z80-based computer called the MTX-512. Standard hardware includes 64K bytes of RAM, 16K bytes of dedicated video RAM, real-time clock, 256- by 192-pixel high-resolution graphics, 40-column text, 16 colors, and user-definable graphics abilities. I/O ports for a Centronics-type parallel printer and two game-controllers are provided along with separate television and video monitor ports, a game cartridge port, an uncommitted port, and a 2400-bps cassette interface. Three voices, high-fidelity output, and a white-noise generator make up the MTX-512's sound capabilities. Its 79-key keyboard has separate numeric and cursor-control pads as well as function keys. Oxford BASIC and an assembler/disassembler are embedded in 16K bytes of ROM.

Network interfacing, up to 512K bytes of RAM, an 80-column video board, dual RS-232C ports, and 5¼- and 8-inch floppy-disk drives with CP/M are offered as options. Pascal and FORTH are available as add-on ROM packs. The suggested retail price for the MTX-512 is $595. For further information, contact Memotech Corp., 7550 West Yale Ave., Denver, CO 80227, (303) 986-1516.

Fiber Optics Link Multiusers in Unix Environment

The Cadmus 9000 family of microcomputers uses a 50-megabit-per-second fiber-optic link to support 64 graphics workstations or more than 100 terminals in a distributed Unix environment. Features of the Cadmus 9790 Advanced Function Workstation include a 10-MHz MC68000 microprocessor, one-half megabyte of main memory (expandable to 4 megabytes), and a bit-mapped graphics controller with a 1024- by 800-pixel display area. An adjustable 17-inch monochrome video monitor, a mouse interface, detachable keyboard, a 65-megabyte Winchester hard-disk drive, a streaming tape cartridge for storage backup, and an optional local-area-network interface make this multiuser Unix-based system unique.

For complete technical specifications, purchasing details, and shipping information, contact Cadmus Computer Systems, 600 Suffolk St., Lowell, MA 01852, (617) 453-2899.

Circle 608 on inquiry card.

High-speed Board for STD Bus

Techno has announced a high-speed 6502-based single-board computer for STD-bus applications. The CPU-100 has a built-in RS-232C serial interface for direct terminal/printer connection and room for up to 8K bytes of memory. Two user-defined I/O ports, two interval timers, serial-to-parallel and parallel-to-serial shift registers, and two bidirectional 8-bit data ports with control lines are included. The CPU-100 can function as the central processing unit of a multiboard system with memory expansion to 65K bytes.

A 2K-byte monitor and mathematics package are available. Contact Techno Inc., 14 Crandall Ave., Pompton Lakes, NJ 07442, (201) 839-0740.

Circle 611 on inquiry card.

16-bit Computer for Business or Personal Use

A 16-bit business/personal computer has been announced by Sumicom Inc. The basic System 330 has an 8088 microprocessor, 128K bytes of RAM, three on-board expansion slots, and a full-function 93-key ASCII keyboard. The low-profile keyboard offers a standard alphanumeric typewriter format that's augmented with 10 numeric keys, 14 editing keys, and eight double-function keys. The System 330 supports CP/M-86, MS-DOS, Pascal, FORTRAN, COBOL, and BASIC. It costs $1795.

A choice of mass-storage options is offered: single or dual 160K-byte 5¼-inch floppy-disk drives, 8-inch drives, dual 720K-byte floppy disks, and 8- or 16-megabyte hard disks. Color and monochrome display screens are available. An expansion box providing six additional slots can be obtained. Also available is a linked software package that interconnects five subsystems: word processing, database management, financial planning, communications, and accounting. At the heart of this software is a system manager that permits data from one application to be extracted and inserted in another.

The System 330A, outfitted with a single 160K-byte floppy-disk drive, MS-DOS, and an eight-color monitor, costs $2695. With dual disk drives and color monitor, the 330B is $3195. A pair of 720K-byte floppy-disk drives comes with the $3625 System 330E. The proprietary linked software is $540. The expansion unit ranges from $510 to $3495, depending on optional capabilities. For further information, contact Sumicom Inc., 17862 East 17th St., Tustin, CA 92680, (714) 730-6061.

Circle 614 on inquiry card.

Dual Floppy Drives in Single Case

Digital Equipment Corporation asserts that its Rainbow 100+ is the first machine from a major vendor to offer 256k-bit memory technology. The 100+ is also said to be the first computer to carry a Winchester hard-disk and twin floppy-disk drives in a single enclosure.

Employing both the 8-bit Z80A and the 16-bit 8088 microprocessors, the Rainbow 100+ comes with 10 megabytes of Winchester storage, 800K bytes of dual floppy-disk storage, serial synchronous and asynchronous communications, memory-mapped video, full international character support, built-in terminal emulator, and a serial RS-232C/RS-423 printer port. Its 128K bytes of RAM is expandable up to 896K bytes. Diagnostics and a computer-based instruction course are supplied. The basic Rainbow 100+ costs $5475, including documentation. An operating-system kit that includes CP/M-86/80 version 2.0 and MS-DOS version 2.05 can be purchased for $250.

Digital offers a choice of white, green, or amber monochrome display monitors. Each 12-inch monitor offers 80- or 120-column displays, bit-mapped graphics, and high-definition characters. The monitors cost $325.

For entering data, Digital markets a low-profile keyboard for $245. Featuring a sculptured key array, the 105-key keyboard is divided into four areas: traditional typing, editing, numeric, and special function.

Options include RAM

memory extensions, high-resolution graphics, complete technical documentation, and a line of printers. Digital Equipment Corporation maintains its corporate headquarters in Maynard, MA 01754.

Circle 619 on inquiry card.

Tabletop Computer

Creative Micro Systems' 9687 computer is available in a variety of setups. This tabletop machine offers 14 internal card slots, Winchester hard-disk capacities ranging as high as 50 megabytes, and up to 1 megabyte of floppy-disk storage. It can be ordered with 10 serial ports and as much as 1 megabyte of RAM.

The basic 9687 features a 2-MHz M6809 microprocessor, 64K bytes of static RAM, two serial ports, two parallel ports, one double-density double-sided 650K-byte floppy-disk drive, a 20-megabyte Winchester hard-disk drive, and the OS-9 operating system. It costs $5995; quantity discounts are offered. For full details, contact Creative Micro Systems, 3822 Cerritos Ave., Los Alamitos, CA 90720, (213) 493-2484.

Circle 618 on inquiry card.

Tax Manager for Accountants

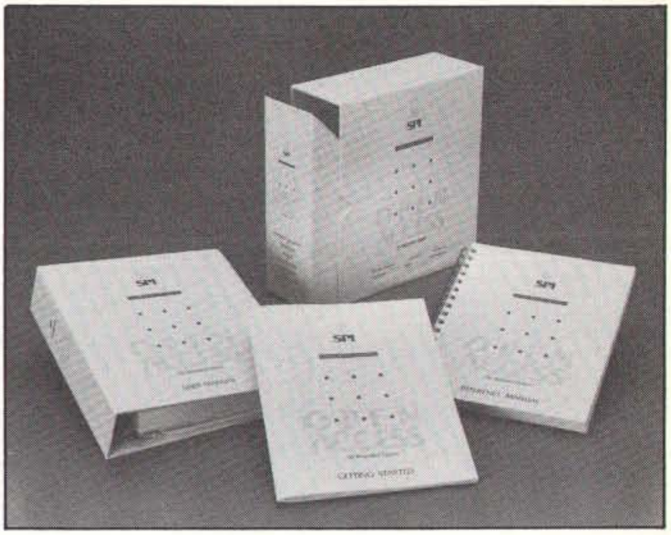
Samuel Klein and Company, certified public accountants, has configured an integrated tax-management system designed to help accountants manage their tax practices. The Tax Manager comprises a portable computer with a self-contained 10-megabyte hard-disk drive, a dot-matrix printer, and a host of accounting software. When equipped with a modem, it can communicate with on-line services. The base price is $4995.

System software represents the foundation of the Tax Manager. A key program, called Tenforty, gives you a single-screen model of IRS Form 1040 so that you can plan taxes for the years 1981 through 1987 in a matter of seconds. For review, you can print out the tax plan. A word processor and spelling checker help you generate IRS and everyday correspondence, instruction letters for tax returns, and mailing labels. An electronic spreadsheet provides the means for creating complex financial models, budgets, and projections. Tax Manager's relational database gives you control over filing requirements, staffing, and status reports. Financial-analysis ratios, Bardahl test computations, and interest schedules can be computed. Other capabilities include general ledger, accounts payable/receivable, and payroll.

Additional software packages are offered. More information is available from Samuel Klein and Co., MAS Software Services Division, 1180 Raymond Blvd., Newark, NJ 07102, (201) 624-6100.

Circle 615 on inquiry card.

SOFTWARE



Business Package Includes Spreadsheet, Graphics Module, Word Processor

Open Access from Software Products International serves as an all-in-one "super program" that's capable of handling the prime tasks of a business manager. Included in this package are an electronic spreadsheet, a three-dimensional color graphics module, a word processor, an appointment scheduler, and a communications module, all of which are centered around a database manager that accesses all input data. Open Access also offers pop-up windows that let you view different forms of information simultaneously without going through menus or command sequences.

Open Access is designed for the IBM Personal Computer, its compatibles, the DEC Rainbow, and desktop computers from Texas Instruments, NCR, and Wang. It costs $595. For more information, contact Software Products International, 10343 Roselle St., San Diego, CA 92121, (619) 450-1526.

Circle 636 on inquiry card.

Business Tool Can Be Run by Novices

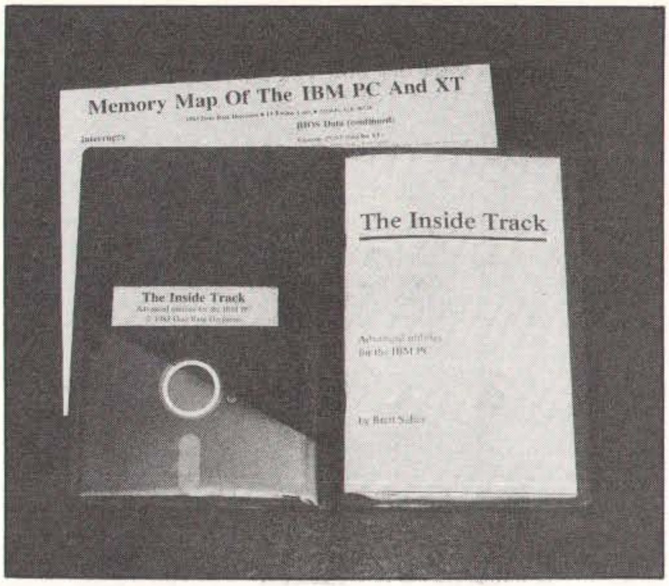
Novices and experts can use Sofstar's Business Planning Tool to create budgets, forecasts, and business plans in familiar income-statement and balance-sheet formats. Accounts are defined by positioning the IBM Personal Computer's cursor at the desired location and entering an account name. Accounts must fall within one of the following categories: income, expense, assets, or liabilities and equity.

The Business Planning Tool features a 12-month window that presents a range of possibilities based on assumptions contained in account descriptions. A graph screen is used to display a horizontal bar graph of an account. All data or individual components of an account can be displayed or edited. Editing of constants and seasonal variations is provided. The Business Planning Tool does not require programming commands or special symbols. All formatting is completely automatic. Another feature is the ability to write complex, preformatted spreadsheets that can be used with Visicorp's Visicalc.

The Business Planning Tool runs on 128K-byte IBM Personal Computers with one disk drive. It costs $195 and is manufactured by Sofstar Inc., 13935 U.S. Highway #1, Juno Beach, FL 33408, (305) 627-5511.

Circle 620 on inquiry card.

Utility Programs with the Inside Track



The Inside Track is a collection of utility programs for the IBM Personal Computer from Data Base Decisions. This package comprises 61 programs that provide you with assembly-language-assisted speed by means of subroutines that can be called from interpretive BASIC or from a compiled language. These subroutines perform such functions as read and write files as fast as DOS, display data on screen four to 10 times faster than the BASIC PRINT statement, copy memory from one location to another, and copy-protect disks. Certain programs let you reverse a block of memory for use as a program scratchpad or limit the memory used by compiled BASIC programs to eliminate reloading of COMMAND.COM and to allow concurrent program loading. Other programs handle such chores as dynamically scheduling up to four programs from within a program.

The Inside Track requires a 64K-byte IBM PC with PC-DOS, a disk drive, and an 80-column monitor. Most of the programs run with any version of PC-DOS; however, a few programs require DOS 2.0, in which case 128K bytes of memory is necessary. This package is available factory-direct for $45, plus $2.50 shipping, from Data Base Decisions, 14 Bonnie Ln., Atlanta, GA 30328, (404) 256-3860.

Circle 635 on inquiry card.

Cash and Time-Management Programs Aid Professionals

American Software Application Programs has announced five cash-control and time-management programs designed for professionals: Due Process for attorneys, Net Worth for CPAs, the Blue Print for architects, the Spec Sheet for engineers, and the Guide Line for consultants. Each program provides complete client accounting with 18 different statement formats, comprehensive management reports, appointment scheduling, and letter writing with name and address merge capabilities. Also provided is a utility program that repairs files and indexes, splits files onto several disks, merges files when upgrading to a hard-disk drive, and backs up files for historical records.

These programs run on CP/M and CP/M-86 systems. They come with documentation designed for first-time users. Free dealer and end-user support is provided over toll-free telephone lines. Each program retails for $995; demonstration kits are available for $70. For more information, contact American Software Application Programs, Suite 270, 100 East Thousand Oaks Blvd., Thousand Oaks, CA 91360, (800) 252-2727; in California, (805) 496-5329.

Circle 626 on inquiry card.

Machine-Independent Operating System

S1 is a general-purpose, machine- and processor-independent operating system from Multi Solutions. Distinctive characteristics include building-block construction, machine-language implementation, system facilities for applications, networking facilities, real-time operation, file-system compatibility, and window management. Up to 256 processors can be simultaneously supported with any task running on the central processor. It offers conventional command processors, menus, and prompts; extensive graphic support; windowing and bit-mapping; and bit-mapped printer/plotter and terminal support.

S1 is portable to a variety of systems, including 32-bit machines. It can read and write files to and from CP/M, MP/M II, MS-DOS, Unix, Xenix, p-System, Flex, and other operating systems. It presently is running on Z80, 68000, and 8080/8085 computers. Languages available include C, FORTRAN, and Pascal.

Prices for a preconfigured S1 package begin at $200. OEM and system houses inquiries are welcome. For a brochure outlining this product, contact Multi Solutions Inc., 660 Whitehead Rd., Lawrenceville, NJ 08648, (609) 695-1337.

Circle 623 on inquiry card.

Write Your Own Programs at Home

Dynatech Microsoftware's Home File Writer enables Commodore 64 and Atari 800 and XL series users to write a variety of applications programs for everyday use. Possible applications include household inventory, recipe files, medical and health records, mailing lists, and tax information. This self-prompting program lets you enter the screen format and calculations onto your monitor in plain English. It then translates your information into a form that will work on the computer. Home File Writer rejects improper or illegal input and gives you another opportunity to enter your data correctly. Once your application program is written, Home File Writer can be removed, which minimizes hardware overhead. Its operation is totally transparent.

Home File Writer is supplied with documentation. It costs $69.95. For more details, contact Dynatech Microsoftware Inc., 7847 North Caldwell Ave., Niles, IL 60648, (800) 621-4109; in Illinois, (312) 470-0700.

Circle 625 on inquiry card.

By a Factor of Two

Two encryption systems based on the National Bureau of Standards Data Encryption Standard have been developed by Prime Factors.

U-Psypher is a file-oriented, interactive program for full-file encryption on computers that run CP/M, MP/M, and MS-DOS. Descrypt/MS is a DES assembler source code for 8080, 8085, Zilog Z80, 8086, and 8088 microprocessors. Both encryptors can be integrated into real-time systems. Implementations, module sizes, and throughput requirements are user-specifiable. U-Psypher costs $99; Descrypt/MS with source code DES is $1500. Contact Prime Factors, 6529 Telegraph Ave., Oakland, CA 94609, (415) 654-5090.

Circle 624 on inquiry card.

Lobo Chats to the Max

Compu-Talk, an assembly-language program, turns the Lobo Max-80 computer into a talking computer. With Compu-Talk, the Lobo can interactively communicate with Votrax's Type'N'Talk or Personal Speech System. This program provides spelled speech, identification of uppercase and lowercase characters, keystroke echo, and audible feed of program control keys. The voice can be switched on or off at any time, and it can be set to spell out acronyms. It speaks and reads the line and column number on which the cursor is located, provides page and line review, and vocalizes special characters.

Compu-Talk requires one 5¼-inch disk drive, Type'N'Talk, a connector cable, and the LDOS operating system. A version is available for Radio Shack TRS-80 Models I, II, III, IV, 12, and 16. Compu-Talk costs $129.95. A complete package containing the program, interface cable, and Type'N'Talk is available for $429.85. The documentation alone is $20. Contact Compu-Talk Systems, POB 28355, Columbus, OH 43228, (614) 279-8271.

Circle 632 on inquiry card.

Drafting Training Program

A computer-aided drafting program for training high school and college students, GRID can produce, store, retrieve, and edit two- and three-dimensional drawings. Entirely menu-driven, GRID (Graphics Instruction Device) runs on Hewlett-Packard HP-85, -86, and -87 desktop computers.

Features of the program include single-keystroke commands, English-language instructions, and the ability to plot drawings on the video display and three-dimensional data in either orthographic, isometric, or cabinet views. A graphics editor lets students see results of an editing command as it's entered, and GRID's single-step mode lets you watch a drawing develop one line at a time. It has the ability to step backward through your drawing command, erasing lines as it goes. Drawing commands include points, arc, circle, polygon, and step/repeat.

With a digitizer module, GRID costs $495, including manual. It's available in 3½- and 5¼-inch floppy-disk formats. Contact Responsive Logic, 156 Donald St., Oregon City, OR 97045, (503) 655-4980.

Circle 622 on inquiry card.

Burroughs Emulation for Personal Computers

Intercomputer Communications Corporation's Intercom 100 software allows such personal computers as Corona, Columbia, Eagle, Compaq, and IBM to emulate a Burroughs MT983/TD830 online terminal. It simultaneously supports up to five addresses: four for concurrent operator dialogues and bidirectional file transfers and one for background printing. This program offers a plain-English configuration and menus that are clear enough for nontechnical users.

Intercom 100 comes on a 5¼-inch floppy disk. Each copy costs $99. For further information, contact Intercomputer Communications Corp., Suite 2A, 3195 Linwood Ave., Cincinnati, OH 45208, (513) 321-3199.

Circle 634 on inquiry card.

What's New?

Visicalc IV Features Graphics, Data Management, and User-Defined Commands

Visicorp has announced the availability of Visicalc IV for the IBM PC and XT. This program integrates all the features of standard Visicalc and extends them with graphics, sorting, spreadsheet management, and a capability for user-defined commands, known as Keysaver. Visicalc IV's new graphics commands let you convert spreadsheet data into a graphical format instantly. "What-if" analyses can be created with a single keystroke that calls up one or more of the eight integral graphics options. Complex or special graphs can be stored on disk and later quickly retrieved with a single keystroke. Graphs can be printed in standard or large size, normal or reverse image, and normal or sideways. Available graphs include area, bar, dot, pie, scatter, line, and such sophisticated graphs as high, low, closed, and stacked and comparative bar. Both monochrome and color graphics are supported.

Visicalc IV's high-speed sorting and rearranging capabilities treat your spreadsheets as if they were a database. This allows you to generate ad hoc reports as well as standard financial models. Sorting can be performed on rows or subsets of rows; columns can be rearranged with a few keystrokes.

The Keysaver feature lets you store a series of Visicalc commands and operations under any key, including function keys. A single file can accommodate as many as 66 user commands. Defining a keystroke sequence is said to be a simple operation because the software continually tracks the last 75 characters typed. At any time, you can recall these keystrokes, define them as a command, and assign them to a function key, or you can modify the sequence if desired.

Visicalc IV is available from Visicorp dealers nationwide. The suggested retail price is $250. Visicorp is headquartered at 2895 Zanker Rd., San Jose, CA 95134, (408) 946-9000.

Circle 638 on inquiry card.

Technical Analysis Tools Bundled in Single Program

A number of analysis tools are packed into the Technical Investor from Savant Corporation. This program contains three types of moving averages, five different volume indicators, regressions, point and figure charts, speed resistance lines, relative strength plots, and oscillator functions. Automatic routines let you define the charts you want. Up to four chart windows can be displayed simultaneously, and each window is independently controllable. If your IBM PC or Compaq computer is equipped with a smart modem, communications with either the Dow Jones News/Retrieval or the Warner Computer Systems database can be achieved with a press of a button. You can also mix the types and amounts of data in disk storage.

The Technical Investor requires 128K bytes of memory, dual double-sided double-density disk drives, and a color graphics card. A dot-graphics printer and a modem are strongly recommended. The list price is $395, which includes a manual with instructions for novices and details for experienced users. Complete information is available from Savant Corp., POB 440278, Houston, TX 77244, (800) 231-9900; in Texas, (713) 556-8363.

Circle 627 on inquiry card.

Teacher Authoring System Is Easy to Use

TAS, Teacher Authoring System, is a menu-driven program that's designed to adapt to any classroom curriculum. Running on the Radio Shack TRS-80 Models III and IV, TAS combines an authoring program with presentation, student records, and file-maintenance programs so that even teachers without programming experience can use it to create computerized lessons. With this program, teachers can write up to 10 pages of text and design graphics to highlight material, store pages temporarily for later recall, add up to 50 questions to reference any one of five review pages, print master lists of questions and answers, and adjust a lesson's format for each student.

This two-module system comes with an instructor disk (with backup) for the development and maintenance of lessons and student records and a student disk with the presentation program and a sample lesson. The user manual contains a tutorial section that describes the lesson development process and a reference section. It requires 48K bytes of memory and a disk drive. The retail price is $149.95. Complete information is available from Teach Yourself By Computer Software, 2128 West Jefferson Rd., Pittsford, NY 14534, (716) 424-5453.

Circle 630 on inquiry card.

Magicbind Upgrades Word Processors

Magicbind is a file-merging program with advanced features for users of Wordstar, Magic Wand, and other CP/M-based text editors that generate ASCII files. At any time with Magicbind, you can insert data items into the main body of a document, merge two or more files into a single document, select records based on special classification codes, verify data-file accuracy by examining the number of fields in each record and the number of digits in a field, print mailing labels, and automatically number chapters, paragraphs, articles, and listed items. Magicbind maintains separate page- and record-number counters, which facilitates selective printing of multipage documents. In addition, it provides more than 60 print-formatting capabilities, including boldface, underline, superscript, subscript, accenting, automatic footnoting, and proportional, nonproportional, justified, and nonjustified printing.

Magicbind requires 48K bytes of RAM and a Diablo 630/1650-compatible printer or a NEC Spinwriter. It costs $250. The print-formatting program, called Magicprint, can be purchased separately for $195. For full details, contact Computer Editype Systems, 509 Cathedral Parkway 10A, New York, NY 10025, (212) 222-8148.

Circle 670 on inquiry card.

Business Package for Model 100

Businesspak+, a set of six cassette-based business programs for the Radio Shack Model 100, has been introduced by the Portable Computer Support Group. The complete package, including manual, costs $89.95.

For word processing, Write+ lets you set margins, right-justify type, and print multiple copies. It has more than 36 features, and it supports both serial and parallel printers. A planning tool and minispreadsheet, Expns+ provides 18 columns with up to 18 entries each. This spreadsheet can give you totals for each day and category. Names of rows and columns can be changed, and replication across columns, cumulative totals, and automatic growth or decline rate projection are offered. All its mathematics functions are built in.

For printing out bar, line, and pie graphs of any Expns+ report, there's Graph+. This program shows the percents on pie charts and the values on other charts, and it works with the DMP-100 and other dot-matrix printers. Put+ lets you list information in an organized manner. It features prompts and the ability to rapidly create addresses or schedule items. Sort+ lets you alphabetically or numerically sort any list compiled with Put+. Telex+ allows you to send mailgram messages over telephone lines.

For full details, contact Portable Computer Support Group, 11035 Harry Hines Blvd., #207, Dallas, TX 75229, (212) 351-0564.

Circle 631 on inquiry card.

Word Processor for Eagles

Muse Word Processing from Marc Software International, which offers an advanced scientific typing feature with 13 levels of super/subscripts, is available for the Eagle PC and 1600 Series computers. Special character sets are supported on the Eagle so that Greek and mathematics characters can be displayed on the video screen. This package provides the processing required to coordinate the key that is struck on the keyboard with the onscreen character and with the character that is printed. Standard features include a spelling checker, mailing-list processor, abbreviation glossary, column functions, automatic hyphenation, and advanced document-selection capability. Muse offers a recovery system that saves a document when your computer crashes and an encryption feature that provides password security.

The Muse Word Processor runs on 256K-byte Eagles supporting a hard disk and DOS 1.1 or 2.0. The single-copy price is $595; multiple discounts are offered. The manufacturer provides full technical support and general information by means of a hotline service. Contact Marc Software International Inc., Suite 200, 260 Sheridan Ave., Palo Alto, CA 94306, (415) 326-1971.

Circle 629 on inquiry card.

Music Learning System

Simply Music is a product for learning music on the Alphasyntauri Computer Music System. This software is designed to enhance the way music is heard, played, and learned. It offers three displays that show live keyboard playing and prerecorded pieces in action: Grand Staff, Keyboard Picture, and Color Bar/Octave. Grand Staff displays bass and treble notes onscreen and, as you play the keyboard, notes and chords are shown on the staff. With Keyboard Picture, the keyboard is depicted in a top-down view on your monitor with each key labeled with its letter name. Individual notes are assigned a color and a position on your screen and each octave has its own row with the Color Bar/Octave display. As notes are played, the color bars light up, showing their relative position within the octave. Song parts can be switched off, lowered in volume, or revoiced for different instruments. Other features include key transposition and speed control.

Simply Music is available for both four- and five-octave Alphasyntauri Music Systems. It costs $199. Complementary courseware packages are offered. A complete Simply Music courseware package, including a four-octave synthesizer, costs $1495. For more details, contact Syntauri Corp., Suite 112, 4962 El Camino Real, Los Altos, CA 94022, (415) 966-1273.

Circle 637 on inquiry card.

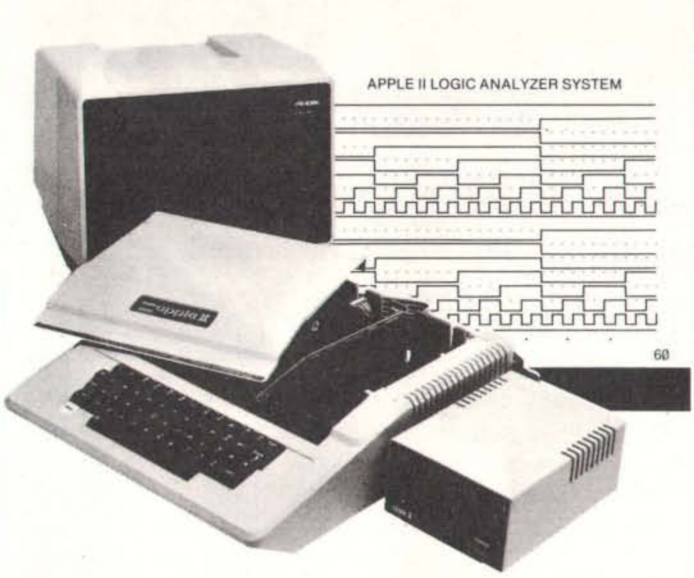
PERIPHERALS

Device Enlarges Displays for Visually Impaired

The Model DP-10 from Visualtek is a plug-in device that aids the visually impaired by automatically enlarging the characters displayed on Apple monitors. This device magnifies characters from 2 to 16 times their original size without operator intervention or special programming. Since the DP-10 enlarges characters up to 5 inches high, only a portion of the original display can be seen at one time. To fix this, a user control panel, operating much like a joystick, provides control over the image. With the control panel, users can access material at speeds of up to 600 words per minute.

The Model DP-10 works with the Apple II, II Plus, and IIe. The base price is $2495. A similar unit for the IBM PC will be announced during the first quarter of 1984. Full details are available from Visualtek Inc., 1610 26th St., Santa Monica, CA 90404, (213) 829-6841.

Circle 651 on inquiry card.



System Converts Apple II into Logic Analyzer

Total Logic Corporation has announced the availability of a hardware and software system that converts the Apple II into a sophisticated logic analyzer. The LA-100 offers such capabilities as a 16-bit-wide data path, 1024-word memory, qualified clock inputs, a 16-bit trigger word that allows data collection to begin or end on the trigger with or without a programmable delay, and the ability to display data either as bits or as a timing-like graphics display. The LA-100 also lets you use your Apple's disk subsystem for both storing and recalling data and instrument setups.

The LA-100 system is made up of a plug-in card, connector cable, and software. It costs $795, including a comprehensive users manual. It can be ordered factory-direct from Total Logic Corp., Suite 110, 343 West Drake, Fort Collins, CO 80526, (303) 226-5980.

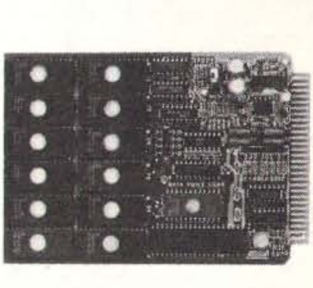
Circle 649 on inquiry card.

Triple Apple Execution Speed

Titan Technologies' Accelerator II is said to more than triple the execution speed of virtually all Apple II and II Plus programs. When attached to any Apple slot, this 6502-based card creates parallel operations: the Apple's main board handles video output while the Accelerator II duplicates the Apple's 48K bytes of memory. In addition, this card supplies the Apple with a built-in language card.

The Accelerator II is hardware compatible with most standard Apple peripherals. All peripherals, however, are not able to run at faster speeds (e.g., disk drives and modems). To compensate for this, switches are provided to decrease the speed for individual devices. The Accelerator II has a suggested retail price of $599. For more information, contact Titan Technologies, 310 West Ann St., Ann Arbor, MI 48104, (313) 662-8542.

Circle 640 on inquiry card.



36 Seconds of Preprogrammed Speech

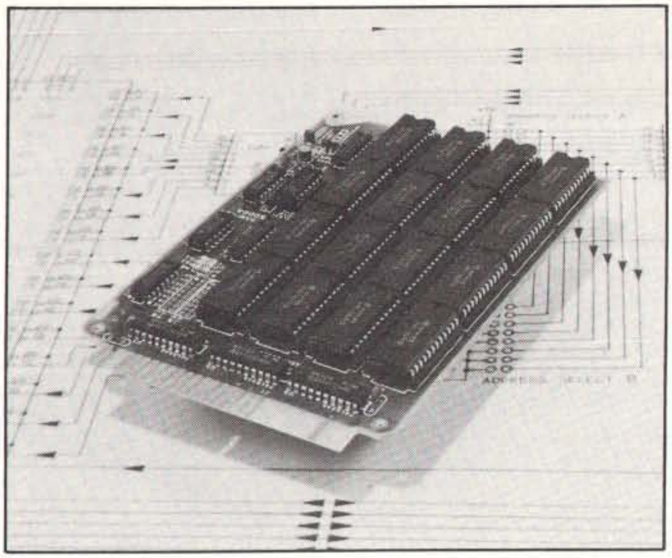
Voice-Alive can be preprogrammed for up to 36 seconds of speech. This speech-synthesizer board is said to provide tape-recorder-quality speech, complete with inflections and emotions. A self-contained unit, Voice-Alive comes with a

1-watt audio amplifier and up to 12 ROMs for vocabulary. Standard features include programmed time delays of up to one hour, a 56-pin edge connector, and eight inputs for initiating separate messages or words. Inputs can be activated by TTL signals or by shorting them through ground contacts. Lookup tables for each input activate single or multiple messages, repeat a single message, or activate multiple messages interspersed with pauses. Voice-Alive can be activated by microprocessor signals or by simple switch closures. It measures 4½ by 6½ inches.

A single Voice-Alive costs between $350 and $750, depending on memory requirements. For orders of one to five units, a vocabulary set-up charge of $250 is applied. Custom vocabularies, such as a foreign language, are available. For particulars, contact Datavoice Corp., Suite 1900, 2 North LaSalle St., Chicago, IL 60602, (312) 327-8488.

Circle 643 on inquiry card.

Module Accepts 32K of Static Memory



The processor-independent 5006A STD bus memory module can accommodate up to 32K bytes of static memory. This module will accept 6116-type RAMs, type 2716 EPROMs, MOS ROMs, and 5-volt pin-compatible EEPROMs. Different types of static memories can be intermixed without module reconfiguration, and unused sockets are automatically disabled. With 6116 series RAMs, access times of 100, 120, and 150 ns are possible. A single 5-volt power supply is required.

The 5006A memory module is available in populated and depopulated versions for $250 and $99, respectively. Contact STD Microsystems, 399 Sherman Ave., Palo Alto, CA 94306, (415) 327-6800.

Circle 650 on inquiry card.

Analog I/O Board Commodore Compatible

The Model 24/8 Analog I/O board expands Commodore VIC-20s and 64s with eight channels of A/D and eight channels of D/A. The A/D converter is 12 bits wide, and its fast acquisition time (100 μs) makes it suitable for data acquisition. The Model 24/8's on-board RAM permits high sample rates and block moves of data to the host computer. The 8-bit D/A channels are suitable for most control applications.

The Model 24/8 can serve as a stand-alone controller or its control loop can be closed with the Commodore for user supervision and interaction. Its sample rate, channel selection, and operating modes are under your control through supplied software.

The Model 24/8 costs approximately $295. Kits may be available during the first quarter of 1984. For full specifications, write to Applied Electronics Consultants, POB 349, Clemson, SC 29633.

Circle 648 on inquiry card.

Finger Print Your Printers

Finger Print lets users of IBM PC and Epson printers select a variety of print functions by merely tapping the printer's panel buttons, eliminating the need for special control characters. Among its 10 special print functions are perforation skip-over, left margin indent, buffer clear, and compressed, double-wide, and emphasized characters. No soldering is required.

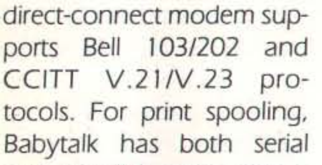
Finger Print is supplied with operating instructions and control panel reference labels. It costs $59.95. Contact Dresselhaus Computer Products, 837 East Alosta Ave., Glendora, CA 91740, (213) 914-5831.

Circle 644 on inquiry card.

Communications Manager Is Z80 Computer

Babytalk is an intelligent communications-management interface for the IBM PC and Texas Instruments Professional Computer. Babytalk, produced by Microlog, is a self-contained Z80-based microcomputer that provides a terminal emulator, a smart modem, a print spooler, 64K bytes of dynamic RAM, CP/M-80 compatibility, and automatic time/date. It emulates such protocols as 3270 bisync and 3270 SNA, and 3780 batch/bisync as well as a variety of asynchronous terminals, including DEC VT-100 and IBM 3101. Its on-board modem offers 300-, 600-, and 1200-bps operation and auto-dial and auto-answer. This direct-connect modem supports Bell 103/202 and CCITT V.21/V.23 protocols. For print spooling, Babytalk has both serial and parallel ports. Other features include a utility that lets you define function keys with multistroke sequences up to 80 characters long.

Babytalk costs $895. For more information, contact Microlog Inc., 222 Route 59, Suffern, NY 10901, (914) 368-0353.
Circle 642 on inquiry card.



Colorful Speech Introduced

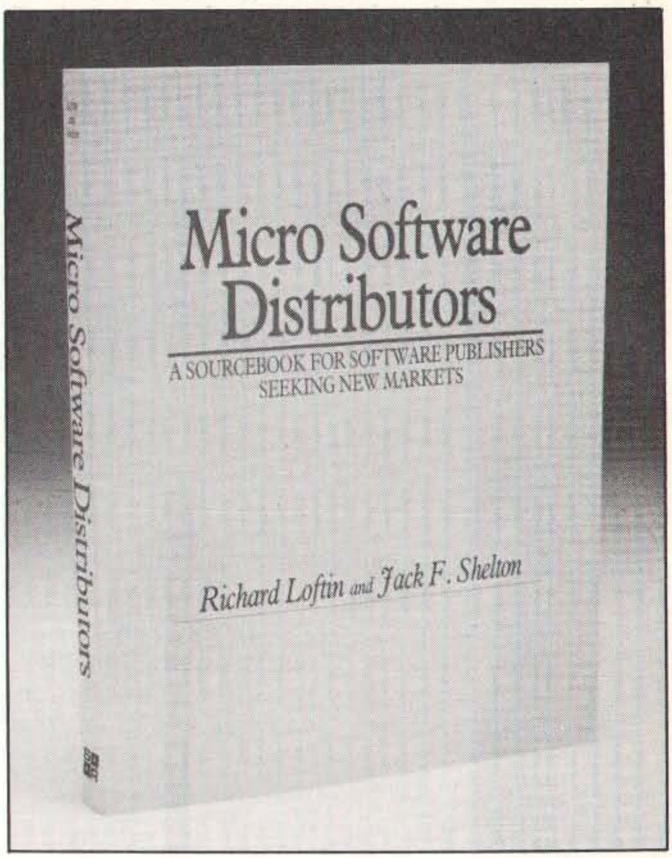
Spectrum Projects has introduced a low-cost voice-synthesizer for the Radio Shack TRS-80 Color Computer. Built around the Votrax SC01 phoneme synthesizer, the Voice Pak has an unlimited vocabulary, automatic inflection, four programmable pitch levels, and the ability to produce a full sentence from a single line of BASIC. It's equipped with a voice editor that can create an unlimited number of words and sound effects.

The Voice Pak ROMpak is supplied with a users manual and a software cassette. Fully assembled and tested, it costs $69.95, plus $3 per order for shipping and handling. Voice Pak is available directly from Spectrum Projects, 93-15 86th Dr., Woodhaven, NY 11421, (212) 441-2807.
Circle 641 on inquiry card.

PUBLICATIONS

Round Table's Gathering

Computer Business is a monthly publication containing abstracts of articles published in business, financial, and computing magazines. Produced by Round Table Associates, the contents explore what's new and significant in computer and communications publications. Topics are arranged under the categories of mainframes, mini- and microcomputers, software, peripherals, data communications, office automation, consumers, electronics, and more. Back issues are $15. Contact Round Table Associates, POB 45923, Los Angeles, CA 90045, (213) 649-2846.
Circle 659 on inquiry card.


Micro Software Distributors
A SOURCEBOOK FOR SOFTWARE PUBLISHERS SEEKING NEW MARKETS
Richard Loftin and Jack F. Shelton
Micro Software Distributors

Directory Focuses on Distributors of Microcomputer Software

A directory that focuses on the microcomputer-software middleman, **Micro Software Distributors: A Sourcebook for Publishers Seeking New Markets,** contains profiles of more than 150 companies that purchase or license software for quantity resale. Each company is described in terms of the software it seeks, what it pays, the marketing rights it obtains, to whom it sells, and the support it provides. Explanations about submitting proposals are included. The directory, which costs $95, covers hardware and software manufacturers, book publishers, retailers, and other organizations seeking programs for resale. Contact Software Research Co., POB 9524, Drawer C, Washington, DC 20016, (202) 364-8700.
Circle 654 on inquiry card.

By and for Lisa Users

Signal is a free newsletter produced by the Semaphore Corporation for users of Apple's Lisa. Its entire format is created using only the Lisa. Subscriptions are free to users who submit the serial numbers of their Lisas. Other readers can subscribe to **Signal** for $10 for 10 issues; $20 outside of North America. Contact **Signal**, 207 Granada Dr., Aptos, CA 95003.
Circle 656 on inquiry card.

What's New?

Japan's News from Satellite

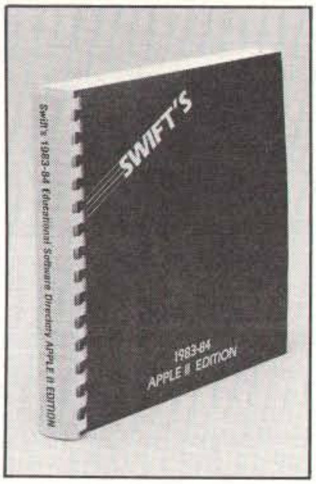
Satellite Systems Engineering of Bethesda, Maryland, produces a biweekly newsletter that is a source of news and information about telecommunications in Japan. It covers such subjects as technological advances, new products, joint ventures, computers, legislative and administrative actions, and people. The **Japan Telecommunications News** costs $325 annually. If you subscribe before 1984, you'll receive a discount. Contact Satellite Systems Engineering Inc., **Japan Telecommunications News**, Suite 520E, 7315 Wisconsin Ave., Bethesda, MD 20814.

Circle 655 on inquiry card.

Vector Electronic Offers Catalog

Almost 1000 electronic packaging, breadboarding, and prototyping items are described in Vector Electronic Company's 68-page catalog. One-third of the catalog covers microcomputer prototyping boards for the VME, S-100, Multi-, and STD-bus systems. Other systems include the IBM PC, Exorcisor, Apple II, DEC, and TI 980. Another section of the catalog covers a large variety of card racks and cases with a cross-index between card size and case-model number. Contact Vector Electronic Co., 12460 Gladstone Ave., Sylmar, CA 91342, (213) 365-9661.

Circle 658 on inquiry card.


SWIFT'S
1983-84 APPLE II EDITION
Swift's 1983-84 Educational Software Directory APPLE II EDITION

For Apple Software In Education

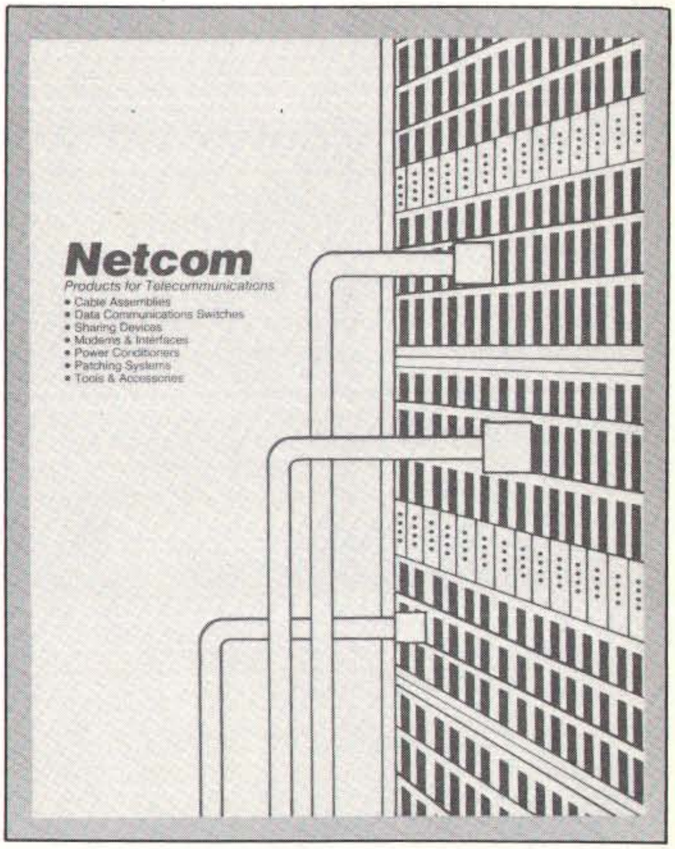
A directory about current educational software programs produced for the Apple II is organized by subject, contains a master index, and provides a publisher-information section. The 1983-84 **Swift's Educational Software Directory—Apple II Edition** reflects this year's increase in software listings with an enhanced format for entries. The price is $18.95. Contact Sterling Swift Publishing Co., 7901 South IH-35, Austin, TX 78744, (512) 282-6840.

Circle 662 on inquiry card.

Free Telex Book

Telex Communications from Your Personal Computer, Word Processor, or Terminal, a 20-page free booklet from RCA Communications Inc., describes how to register for the Telex service, the telephone interface and signaling protocol required, how to send a Telex message in real time or store and forward, and how to receive incoming Telex messages through real time or an RCA Databank. It includes sample formats as well. For details, contact RCA Communications Inc., 60 Broad St., New York, NY 10004, (212) 806-7736.

Circle 663 on inquiry card.



Products for Telecommunications

A free 12-page catalog is available from Netcom, manufacturers of telecommunications equipment and accessories. The catalog includes information on cable assemblies, datacommunications switches, sharing devices, modems and interfaces, power conditioners, patching systems, and other tools needed in telecommunications. The company's product line includes a full range of AC power-line conditioning equipment, filters, and voltage regulators, and services such as system design, installation, and testing. For a catalog, contact Netcom, 79 Hazel St., Glen Cove, NY 11542, (516) 671-8811.

Circle 653 on inquiry card.

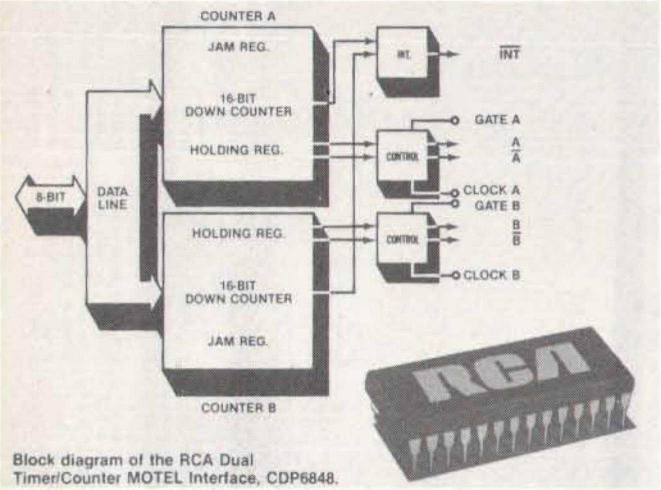
For Your 64

What's? for the 64 is a resource guide of new products for the Commodore 64 computer. Over

100 pages include information about programs, software, peripherals, interfaces, book titles, magazines, and user groups that cater to the Commodore 64. It includes a directory of sources that focus on operating needs encountered by owners. The book includes a magazine-article bibliography of literature and written programs. The guide sells for $15. Contact **What's? for the 64**, 3494 Chickasaw Circle, Lake Worth, FL 33463.

Circle 661 on inquiry card.

CHIPS



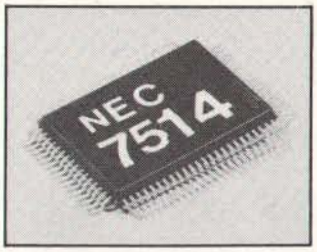
Block diagram of the RCA Dual Timer/Counter MOTEL Interface, CDP6848.

Chip Counts and Times

A CMOS dual counter/timer chip is compatible with general-purpose and multiplexed address and data buses of popular microprocessors. The CDP6848 is a CMOS peripheral device capable of operating on the Motorola-Intel (MOTEL) microprocessor bus in five modes. The chip accepts separate read and write signals or a common read/write signal with a data strobe. Counters and registers can be addressed in memory directly by such microprocessors as RCA CMOS CDP6805, 8048, 8049, 8051, and NSC 800. Contact RCA/Solid State Division, POB 3200, Somerville, NJ 08876, (800) 526-2177; in New Jersey, (201) 685-6423.

Circle 667 on inquiry card.

4-bit $mart LCD Driver/Controller



A CMOS 4-bit, single-chip LCD controller/driver called the μPD7514 can drive either three or four backplanes in triplexed or quadruplexed modes or two backplanes in biplexed mode. It offers low power consumption and operates from a single +5-V power supply. Other features include four vectored interrupts (two internal and two external) and two standby modes. Its instruction set consists of 97 instructions. The μPD7514 is available in an 80-pin flat-pack configuration. It costs $8.95 for large-quantity orders and is available from NEC Electronics USA Inc., One Natick Executive Park, Natick, MA 01760, (617) 655-8833.

Circle 668 on inquiry card.

Low-Power Quad Comparator

The LP339 consists of four independent voltage comparators in a single chip designed to draw only 60 microamperes of total current. Each comparator operates over a common-mode voltage range. The LP339 is designed to interface with the CMOS logic family. It includes sensing at ground potential, a pin-out identical to the LM339, and high-output sink-current capability. It is protected against reverse voltages and will operate from single- or split-power supplies. Characteristics include a low-input biasing current and a low-input offset voltage. The cost per unit is 72 cents in quantities of 100 or more. Contact National Semiconductor Corp., 2900 Semiconductor Dr., M/S 1925, Santa Clara, CA 95051, (408) 721-5856.

Circle 666 on inquiry card.

RMS-to-DC Converter

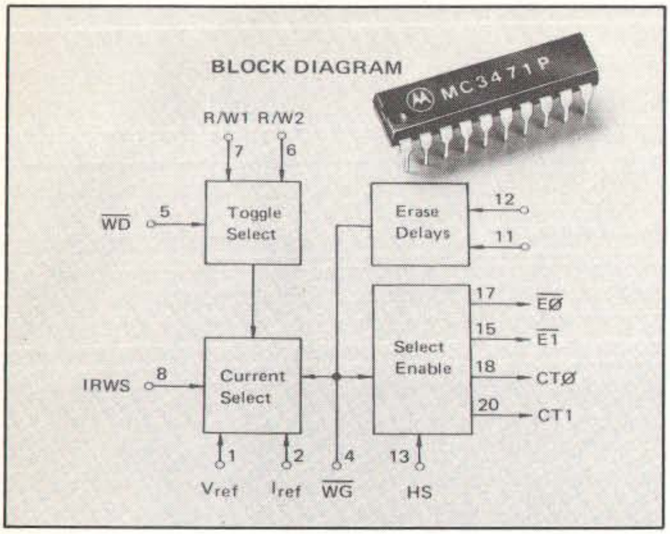
The AD637 is a root-mean-square to DC converter that offers accuracy and wide bandwidth with 0.02 percent nonlinearity. Operating from DC to 8MHz with a maximum of ±0.5mV fixed offset and ±0.2 percent of reading total unadjusted error, a single external capacitor sets low-corner frequency and determines low-frequency accuracy, ripple level, response speed, and settling time. The AD637 computes the true root-mean-square value of complex AC waveforms and operates with ±3-V to ±18-V supplies. An on-chip buffer amplifier provides typical 5-V/μs slew rate, maximum ±2mV input offset, and maximum 5nA bias current. It is packaged in a 14-pin ceramic package. In quantities of 100 or more, the AD637 is priced from $13. Contact Analog Devices, Rt. 1, POB 280, Norwood, MA 02062.

Circle 664 on inquiry card.

Write Controller/ Head Driver

A tunnel-erase floppy-disk controller with erase delays, the MC3471P from Motorola is a write controller/head driver integrated circuit designed to provide the entire interface between the write-data and head-control signals

What's New?



and the heads (write and erase) for either tunnel- or straddle-erase floppy-disk systems. It combines all write functions formerly accomplished using separate building blocks or discrete transistors.

Means for selecting a range of write currents and for head selection during both read and write operations are provided. Provision is also made for adjusting degauss period, inner-outer track compensation, and the delay from write gate to erase turn-on and turn-off. In quantities of 100 or more, the MC3471P is $4.25. Contact Motorola Semiconductor Products Inc., POB 20912, Phoenix, AZ 85036, (602) 897-3826.

Circle 665 on inquiry card.

FOREIGN

80 Columns for the HX-20

An intelligent terminal emulator with an 80-column printout capability, ITE+ has been developed by Transam for installation into the main body of the HX-20 or the expansion unit. The machine-code program in ROM allows the HX-20 to be linked to a larger computer and to act as a device for entering and receiving data. This communications link may be made via cable or telephone line.

ITE+ can be used for editing text to be transmitted or for reviewing messages already received. Text, once prepared, can be saved to a file, transmitted, or printed. The editor uses the HX-20's virtual screen and scrolls left and right for a full line length. For viewing and correcting data, you can display a single line of text by using 4 lines of 20 columns for a total of 80 lines of displayed text. ITE+ has the ability to print a full 80-column line. It does this by printing the text out sideways in blocks of 18 lines.

Optionally, Transam offers a parallel interface and a battery-powered acoustic coupler for the HX-20. The interface lets you connect the HX-20 to an external parallel printer and print data when the serial port is taken up with an acoustic coupler or cable.

ITE+ costs $50, plus VAT (value-added tax). The parallel interface is $85, plus VAT. Contact Transam Microsystems Ltd., 59/61 Theobald's Rd., London WC1X 8SF, England; tel: 01-405 5240/2113; Telex: 24224 (Ref. 1422).

Circle 675 on inquiry card.

Three New Cards

Three add-on cards from Rade Systems Ltd. plug into the company's Z80-based single-board computers. The first card, featuring a 10-MHz 8086 processor card, has 128K bytes of on-board memory, expandable to 1 megabyte, which can be added to an optional 8087 coprocessor. The second card is a 512 by 512 graphics card with a high-speed plot rate to a maximum of 1.5 million pixels per second, in either 8 colors plus cursor or a 16-gray scale. The third card, soon to be available, is a 10-MHz 16032 processor card with 128K bytes of on-board expandable memory in 256K-byte increments. Both the 16082 memory-management chip and the 16081 floating-point processor are available on-board as optional devices. Contact Rade Systems Ltd., 290a High Rd., Willesden, NW10 2EU England; tel: 01-451 4414/5/6.

Circle 674 on inquiry card.

Five Versions of the Big Buffer

The Big Buffer hardware spooler for parallel printers increases system speed. Its I/O ports are Centronics-

What's New?

compatible. Five versions with memory capacities ranging from 8K to 120K bytes are available. The spooler features a reset key that clears the buffer contents and a monitor mode in which each character sent from the computer is printed in hexadecimal and ASCII codes, making it possible to inspect all codes that are sent from the computer to the printer. An optional 110-V AC, 60-Hz power supply costs $30. Prices range in U.S. funds from $170 for the 8K-byte version to $363 for the 120K-byte version. Dealer inquiries are welcome. Contact Mikrocomputertechnik, Winchenbachstr. 3a, POB 201 605, D-5600 Wuppertal 2, West Germany; tel: 0202/510444.

Circle 673 on inquiry card.

Apples for All

Technical Aids & Systems for the Handicapped (TASH) has developed a Mod Keyboard System that allows disabled persons to operate an Apple II Plus with standard software. Words, phrases, and standard characters are displayed on the keyboard. Up to 14 displays of time-saving words, phrases, and commands are displayed by the keyboard; additional displays, words, and phrases can be customized. Users can create and edit text or messages up to 500 characters long. Color and audio are available together; black-and-white disables audio feedback. The Mod Keyboard System includes a Commodore VIC-20, a direct-scan cartridge, monitor, ability switch, and user manual. Although it contains a VIC, the system can be used with an Apple II Plus and multiplex circuit board and a connecting cable or compatible printer. Prices vary depending on features. For details, contact TASH Inc., c/o Sunnybrook Medical Centre, 2075 Bayview Ave., Toronto, Ontario M4N 3M5, Canada, (416) 486-3569.

Circle 669 on inquiry card.

Magnum Portable Features Pop-up Display

The Dulmont Magnum portable computer features a pop-up, eight-line by 80-character LCD. Standard hardware includes the 16-bit Intel 80186 microprocessor, 128K bytes of ROM, two serial ports, one parallel port, a real-time clock, and a bus expansion socket. The Magnum can be equipped with up to 256K bytes of battery-backed CMOS RAM and an additional 128K bytes of ROM. It has a full-size QWERTY keyboard with user-definable function keys and a power-save circuit that shuts down the central processor when it's been idle. A word processor, a spreadsheet, a planner/diary, and BASIC-86 are supplied in ROM. The operating system is MS-DOS. Its approximate size is 12 by 11 by 2 inches (305 by 280 by 51 mm). It weighs about 8 pounds (3.5 kg).

The Dulmont Magnum costs less than $2500 (Australian dollars). For full information, contact Dulmont Electronic Systems, POB 1668, Hornsby Northgate, New South Wales 2077, Australia; tel: (02) 477 6444; Telex: AA74936 DULMON.

Circle 672 on inquiry card.

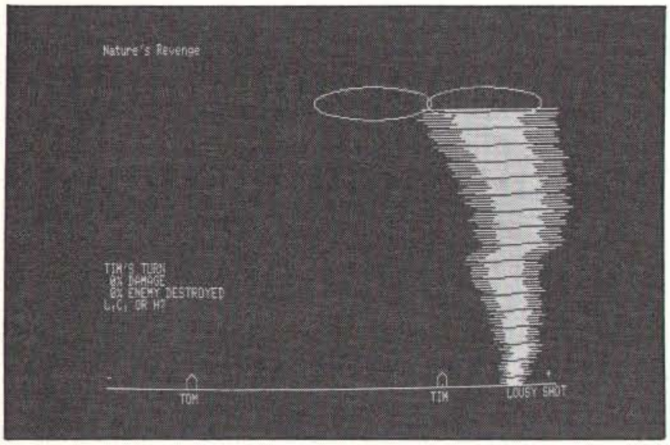
Bubble Memories Have Password Security

Ecosea Technologies has unveiled a line of magnetic bubble-memory cards for the IBM PC and PC XT. Two versions are available: the PDIB128, which provides 128K bytes of nonvolatile storage, and the PDIB384, a 384K-byte card. Either card resides in a single IBM slot, using only two I/O lines. Hardware-based password security is a key feature of these nonvolatile memories. Once you create a password, you can use it to lock up the computer, the bubble memory, or both. No method of bypassing or illegally reading the password is said to exist.

Ecosea's bubble memories operate as a standard DOS 2.0-type device. They are compatible with all DOS software and do not require any patching of system files. DMA and interrupts are supported but not required. Comprehensive diagnostic software, utilities, and installation and operator manuals are provided. The PDIB128 and the PDIB384 cost $995 and $1995 (Canadian funds), respectively. For more information, contact Ecosea Technologies Corp., Unit 13, 465 King St. E, Toronto, Ontario M5A 1L5, Canada, (416) 366-1000.

Circle 671 on inquiry card.

GAMES



Trio of Games for Televideos

Fun & Games Software markets a three-pack of games for Televideo 803 and Teletote computer users. The three high-resolution graphics games are Nature's Revenge, Cannon Shoot, and Lunar Module. Each features animated displays depicting the actions and movements for all phases of the game.

The 803 Games-Pak costs $46.50. It can be ordered directly from Fun & Games Software, 3333 East Redlands, Fresno, CA 93726, (209) 226-1918.

Circle 683 on inquiry card.

Here's One for Woody Allen

Bombs Over Manhattan is a strategic defense game from Tamalpais Software. The object of the game is to defend your city from enemy attack and accrue enough points to allow peace talks to begin. When peace is achieved, you can reconstruct damaged portions of your city and move on to the next level of play. Points are scored by intercepting bombs and missiles. If you lose, your city is consumed to the refrain of "We'll Meet Again." Your city can be one of nine major American cities or one of your own design. Three levels of difficulty are offered: Neophyte, Moderate, and Idiot Savant. A unique feature of Bombs Over Manhattan is its Someone's Coming mode, which is a tiny word processor that can be accessed during any point in the game. The word processor lets you write, edit, print, and store documents up to 66 lines long.

Bombs Over Manhattan runs on 64K-byte IBM Personal Computers with PC-DOS, a color graphics card, and a double-sided double-density 320K-byte floppy-disk drive. A joystick is optional. The suggested retail price is $29.95. Dealer inquiries are welcome. For more information, contact Tamalpais Software, POB 02338, Portland, OR 97202, (503) 232-0021.

Circle 689 on inquiry card.

Devilish Game for TI-99/4A

Diablo, designed for the TI-99/4A computer, consists of two tracks on each of 116 movable panels for a total of 232 tracks. Players must arrange the twisted tracks to keep a moving ball on a continuous path. Each section of track is removed from play after it has been negotiated. Diablo becomes increasingly difficult as less and less track is available to support the advancing ball. This graphics game can be operated by joysticks or through keyboard control. Sound effects add to the fun.

Diablo requires 16K bytes of memory and the Extended BASIC module. It's available on cassette or floppy disk for $19.95 from the Extended Software Co., 11987 Cedarcreek Dr., Cincinnati, OH 45240, (513) 825-6645.

Circle 688 on inquiry card.

Three-dimensional Game for Apple

Cubit, an arcade-type game for Apple computers, uses a three-dimensional pyramid made up of cubes as its playing field. The object is to change the color of all the cubes by hopping from one to another. You must avoid bouncing balls, snakes, and gremlins. Your safety rests upon a set of transport disks and a magic star.

Cubit features four levels of difficulty, each of which is divided into four rounds of play. It's playable with either a joystick or keyboard on 48K-byte Apples running DOS 3.3. The suggested retail price is $39.95. Dealer and distributor inquiries are invited. Cubit is produced by Micromax Systems Inc., 6868 Nancy Ridge Dr., San Diego, CA 92121, (619) 457-3131.

Circle 682 on inquiry card.

Computerized Coloring Book Has 25 Hi-Res Pictures

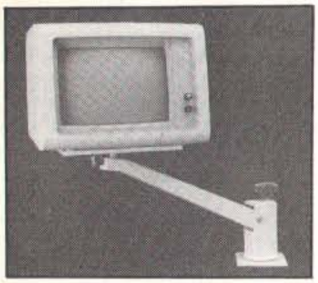
Versa Computing's Color Me is a computerized coloring book suitable for children ages 3 to 12. It's composed of 25 high-resolution pictures of varying degrees of difficulty. Each

Color Me picture is sprinkled with objects and animals familiar to children and has a large, uppercase title to help reinforce word and subject recognition. Children use paddles or joysticks to choose colors from the more than 30 available and to select program options. Color Me pictures can be used over and over again.

Color Me comes on floppy disk for Apple II Plus/IIe and IBM Personal Computers and on cassette for the Radio Shack TRS-80 Color Computer. The retail price is $29.95. Contact Versa Computing Inc., Suite 104, 3541 Old Conejo Rd., Newbury Park, CA 91320, (805) 498-1956.

Circle 684 on inquiry card.

MISCELLANEOUS



Adjustable Arm Lifts Monitors Up and Away

Lintek's Monitor Mover is an adjustable mechanical arm that holds most computer displays up and off your desk. This system is made of a heavy-duty desk clamp, a 360-degree swivel base, a 15-inch vertically adjustable arm, and a CRT mounting tray. The tray swivels and can be tilted up to 15 degrees. Each Monitor Mover features steel construction and an off-white urethane finish.

Optional extended monitor cables and two additional styles of desk mounts are available. The list price is $129.95. For details, contact Lintek Inc., POB 8056, Grand Rapids, MI 49508.

Circle 694 on inquiry card.

Coin Vending Control System for Libraries

XCP's fully automated vending control systems allow library patrons to use microcomputers without staff supervision to control time and usage. Two versions of the Microvend Computer Usage Control System are available: the 3300T and the 5500T. The Model 3300T accepts quarters and tokens; it does not make change. The 5500T accepts nickels, dimes, and quarters. It also accumulates coins until the correct amount is deposited and makes change.

Both systems can be adjusted to provide 1 to 25 minutes of equipment usage. A cumulative time capability allows unlimited equipment time; each time the correct vend price is deposited, another time unit is added. An override key allows free computer usage by staff members. Other features include an accounting meter, a shutoff warning signal, lighted coin-deposit indicator, and multivending capabilities. Installation is simple: plug the computer's CRT power cord into the Microvend control box, close and lock the door, and plug the computer and Microvend into a wall socket.

An annual rental without a purchase option or a 36-month lease term with a 20 percent purchase option are available. For full contractual information, contact XCP Inc., 8 West Main St., Dryden, NY 13053, (607) 844-9143.

Circle 695 on inquiry card.

State Analyzer Can Be Carried into Field

The Micro Tracer state analyzer offers a 1K-byte trace buffer, pattern-recognition logic, and formatted serial output in a box weighing less than 5 pounds. Plug-in personality modules interpret processor codes, and an 18-inch ribbon cable with a 40-pin clip to place over the microprocessor sets up the Micro Tracer. Data is captured by either a 16-bit trap address entered by the front-panel keyboard or by a separate trigger probe that connects to any logic-level signal in the system. Data can be displayed or printed in sequential processor cycles or disassembled and presented in assembly mnemonics. Micro Tracer can display data one cycle at a time on a front panel LED.

Micro Tracer's base price is $995. Personality modules are available for Z80/Z80A and 8085/8085A microprocessors; other modules are under development. Additional modules cost $200 each. For full details, contact Spywood Systems, POB 794, Holliston, MA 01746.

Circle 691 on inquiry card.

Visicalc Wall Chart Guides Users

A two-color, 18- by 25-inch wall chart graphically depicting all Visicalc commands is available from Crest Software. Keystroke combinations with explanations, editing key combinations, operators, and math functions are all covered. A Superscripsit wall chart for the Radio Shack TRS-80 Model III is also available.

Each wall chart costs $4, plus $2 shipping. They can be ordered from Crest Software, 2132 Crestview Dr., Durango, CO 81301, (303) 247-9518.

Circle 690 on inquiry card.

Where Do New Products Items Come From?
The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

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ML/CRJ/EJ @	39.95	33.00
ASHTON-TATE™		
dBase II	700.00	395.00
BPI Systems™		
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BRODERBUND™		
A.E.	34.95	25.00
CENTRAL POINT SOFTWARE		
Copy II Plus	39.95	32.00
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Home Accountant	74.95	49.00
FCM	99.95	68.00
DOW JONES SOFTWARE™		
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FOX & GELLER™		
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dGraph	295.00	195.00
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Zork I/II/III @	39.95	27.00
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	LIST	SALE
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Qbase	189.00	139.00
Templates PO/INV @	49.95	39.00
ML/CRJ/EJ @	39.95	33.00
ASHTON-TATE™		
dBase	700.00	395.00
CENTRAL POINT SOFTWARE		
Copy II PC	39.95	32.00
CONTINENTAL SOFTWARE™		
Home Accountant	150.00	89.00
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ML-84S	1495.00	1129.00
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ML-92S	799.00	599.00
ML-93S	1349.00	1019.00

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Circle 489 on inquiry card.

BYTE's Bits

Two New Office Products from IBM

by Rich Malloy

Practically every major computer company has tried either to imitate the IBM Personal Computer or to design peripherals for it. And now even IBM has jumped on the bandwagon. By IBM, we mean of course not the small Entry Systems Group in Boca Raton, Florida, which produces the popular PC, but the large Information Systems Group, which produces those large systems that are almost synonymous with the IBM logo. Recently, amid a flurry of rumors about the new Peanut or PC Junior, the Information Systems Division announced two significant products based on the PC: a desktop System/370 and a new version of the IBM 3270 display terminal that features concurrent processing and windows.

The IBM Personal Computer XT/370

As its name implies, this new enhancement of the IBM PC XT is designed to emulate the legendary IBM System/370 mainframe. According to IBM, it should run many of the same programs that run on the large machines in the System/370 VM/CMS (Virtual Machine/Conversational Monitor System) family. In addition, the machine has the capability to function as an IBM 3277 display terminal connected to a host computer. And it is still functional as a PC.

The cost for the complete XT/370 system with 10 megabytes of disk storage is \$8995. (A 20-megabyte system will cost \$11,690.) An upgrade kit for an XT will cost \$3790. You will also need, however, a new software package (called VM/PC), which costs \$1000, and a monitor and adapter board for each of these hardware configurations. Thus, for about \$10,700, you can have the equivalent of a small System 370 on your desk.

The XT/370 (which, following a tradition of hard-to-remember 4-digit names, is officially called the 5160 Model 588) consists of a standard XT plus three additional boards. One is a new terminal-emulation board that emulates the IBM 3277 display terminal. The second contains 512K bytes of memory. The third contains a set of coprocessor chips.

The three processors on this board were all produced by IBM in association with Intel and Motorola. The first is based on the Intel 8087 and handles floating-point arithmetic. The remaining two are based on the Motorola MC 68000. One of these can directly execute 72 of the instructions used by the 370. The second can emulate 45 of the 370's other instructions. A few remaining instructions that refer specifically to the 370 have not been emulated.

The VM/PC (Virtual Machine/Personal Computer) software runs under PC-DOS version 2.0 and enables the XT to function as a single-user virtual machine with 480K bytes of real memory and up to 4 megabytes of virtual memory.

As for performance, the XT/370 is hindered by the relatively slow speed (compared to mainframes) of its disk drive. But within this constraint, IBM claims that for commercial applications the XT/370 is about half as fast as an entry-level IBM 4300 system. For scientific applications, the XT/370 should be twice as fast, thanks to the 8087 chip.

The XT/370 should run several popular compilers without any alterations. These include OS/VS COBOL, VS FORTRAN, and Pascal/VS. These programs, along with customer application programs, can be downloaded from a host 370 system. Special reduced monthly charges will be assessed by IBM for 370 software used on the XT/370.

This new system should be available during the second quarter of 1984. Don't look for it in your local Computerland store, however. IBM plans to offer it only to large customers through its National Accounts Division, at least for the time being. One wonders if, a few months down the road, Amdahl and Prime will offer similar products at reduced prices.

The IBM 3270 Personal Computer

This second product from the Information Systems Group combines a standard IBM PC with an IBM 3270 display terminal. The noteworthy feature of this system is its capability to access up to four programs running concurrently on one or more host computers, along with a PC-DOS application program and two "notebook" data areas. Also, a new high-resolution monitor is available for this system.

The 3270-PC has 256K bytes of memory, with options available for up to 640K bytes. A 122-key keyboard includes all of the keys of both a regular PC and a 3270 terminal.

The color monitor (called the 5272—another four-digit name) features eight colors with a very high resolution, equal to that of the PC's monochrome monitor. An antiglare screen is also provided, but bit-mapped graphics are not. It seems a safe bet that a graphics adapter board will soon be available for this monitor and that it will be the new color monitor for the PC. The price for this new display is \$995.

The 3270-PC Control Program, which runs under PC-DOS 2.0, allows you to access up to seven programs: four on a host computer through the 3270 link, two "notebook" data-storage areas, and a PC-DOS application program. You can define a number of windows through which you can monitor any of these programs. You can define the size, color, and position of any of these windows.

The Notebook data-storage areas let you transfer data from host programs to PC-DOS programs and vice versa. The size limit for each area is about 4000 bytes, and you can easily edit the contents of the notebooks. For example, you can run Lotus's 1-2-3, select part of the results for transfer to a Notebook area, add some descriptive labels, and then transfer the Notebook contents to a host computer's electronic-mail program.

The cost for a 3270-PC system with 256K bytes of RAM is \$4290. Additional requirements include the 3270-PC Control Program (\$300) and a monitor plus adapter board. It should be available from IBM's National Accounts Division in the first quarter of 1984.■

Rich Malloy is BYTE's product-review editor.

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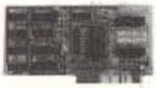

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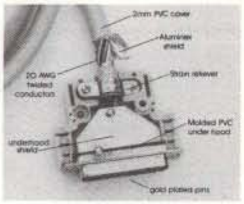

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Book Reviews

Electronically Speaking: Computer Speech Generation

John P. Cater
Howard W. Sams & Co.
Indianapolis, IN: 1982
232 pages
softcover, $14.95

Reviewed by
Joseph A. Scott

Most technical books tend to be written for people who already know the fundamentals of a particular field but who need to broaden their expertise. Other technical books offer a cursory treatment designed for people who want a general idea of a certain field without the details. Both alternatives are unsatisfactory for the novice who is genuinely interested in developing a particular skill or expertise but who has no previous knowledge. *Electronically Speaking* addresses itself to just such a reader.

Cater's book is written for "the neophyte to speech synthesis." It assumes the reader has some knowledge of computer operation, a modicum about computer architecture and electronic circuits, and an awareness of the ways a computer can interface with the world. Both the neophyte and a more advanced student of speech synthesis now have a ready source of information about a variety of products currently available to generate computer speech as well as a baker's dozen of circuits for speech-synthesis applications that you can build yourself.

The heart of the book lies in the sixth chapter. Here Cater details three major technologies in artificial-speech production: waveform encoding for speech reconstruction, the analog-formant-frequency synthesis method, and LPC and PARCOR synthesizers. Visual and verbal analogies and examples, block diagrams, flowcharts, and skeleton schematics enhance the neophyte's understanding. Chapter 6 also compares the technologies in terms of quality and understandability of the produced speech, cost, and memory requirements.

Chapter 7 reviews 16 speech-synthesis peripherals for small computers ranging from Centigram Corporation's Cindy (formerly called LISA) to Texas Instruments' Speak & Spell. Each peripheral is categorized by the type of speech-generating technology it uses, and the author compares each in terms of its theory of operation, vocabulary, storage capability, and cost. The chapter includes photographs of a few synthesizers, some of the internal hardware, block diagrams of the operating systems, and relatively complete or skeletonized schematics. It includes three summary charts for each type of synthesizer and compares the models in such areas as size, speech capability, computer type used, and cost. Although the author points out that some incomplete descriptions are due to the proprietary nature of some of this information, that is to be expected in a new field. This caveat does not detract from the chapter's value. This chapter is informative for people who are either contemplating adding speech to a computer or who want to be able to intelligently discuss the state of the art in speech synthesis.

While chapters 6 and 7 delineate the state of the art in voice synthesis in terms of how it is achieved and what is available, two other chapters discuss the historical development of speech-making devices and the potential of synthesizers today. The chapter on history provides a brief but fascinating discussion of early speech-making devices that range from von Kempelon and Wheatstone's talking bellows to the Voder synthesizer displayed in 1939 at the World's Fair.

The last chapter offers a potpourri of uses for voice synthesizers for home and commercial applications. Here those of a more practical bent may be somewhat disappointed because the uses suggested are currently met adequately and inexpensively by bells and alarms.

But several intriguing questions must be answered before artificial speech can become a part of mainstream technology. Cater addresses both the equipment end and the less tangible aspects of communication humans take for granted. This additional dimension is found in a couple of chapters that discuss human speech. One chapter focuses on the physical, physiological, and neurological mechanisms of speech production. This chapter is a useful reference point to understanding the standards against which artificial speech will be compared. It also provides an awareness of the complexity of human communication that must somehow be replicated by a mechanical or electronic system.

A chapter on linguistics provides a look at the characteristics of what sounds are produced, classifies the sounds produced in speech and used in English, and describes how they are produced. Three tables in this chapter provide handy information for the new user of speech synthesizers. The tables list the most frequently used speech sounds and spoken words in the English language and the relative power of a selection of speech sounds. This informs the novice who is developing a vocabulary of the words he will need and the sounds he has to perfect to make synthesized speech more understandable.

Finally, mention must be made of a chapter that raises questions and makes suggestions about a topic rarely mentioned in technical books. Cater devotes a chapter to what he calls the "etiquette of computer speech." He raises the issue of how humans will react in a world where not only people but things talk and where the things are not adept at responding to social signals that say "shut up." Cater makes us aware of subtler aspects of human communication that presently lack parallels in talking computers. For instance, humans usually tell each other nonverbally when they are about to speak and then await recognition. To do otherwise begs being labeled something ranging from aggressive to boorish. Unless our talking computers are programmed to similar good manners, we may find ourselves in the midst of an armada of aggressive, boorish appliances.

I wish the author had included a discussion of some of the considerations and problems associated with installing a speech synthesizer on a personal computer, Murphy's Law being what it is. And I could have used some guidance on how to improve a synthesizer's diction, elocution, or what have you. Perhaps these concerns are so vast that they could fill another volume.■

Joseph A. Scott (6 Mione Way, Chico, CA 95926) is a psychology professor at California State University in Chico.

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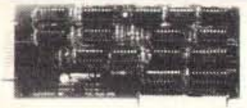

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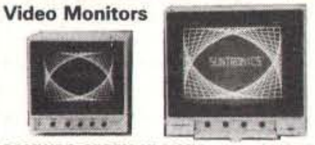

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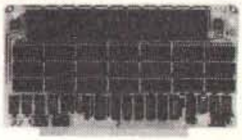

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Book Reviews

Mastering CP/M

Alan R. Miller
Sybex Inc., Berkeley, CA:
1983
400 pages, $25

Reviewed by
Bruce R. Evans

At last, someone has written a book for those of us who hanker to get into the guts of CP/M but lack the perseverance to get through Digital Research's obtuse manuals. Oh, there are lots of introductory books that start with "This is a disk. There's a hole in the middle of it. Insert it into the drive as in the photo." However, a lot of us passed that phase years ago. We want to modify our disk-operating systems to run modems, printers, and even hard disks. Until now, nobody seemed interested in us.

Sybex Inc. and Alan R. Miller have come to our rescue. Miller starts with an overview of the layout and location of the CP/M operating system. He quickly goes through the standard acronyms—CCP, TPA, IOBYTE, and the like. Miller deftly puts these rather vague concepts into perspective. He then does the same with the built-in commands and transient programs such as Pip, Stat, and Mac, Digital Research's macro assembler. Emphasis is solely on assembly-language utilities. Before you know it, Miller has covered what most other authors spend a book on and you are doing things like writing an assembly-language program to let you restart a crashed program.

Chapter 2 is worth the price of the entire book. Although I am proficient in assembly-language programming, I have never quite been able to understand how to modify the low-level BIOS (basic input/output system). I doubt I am alone. And unless you already know how to do it, the CP/M manuals are hopeless at explaining this procedure. Most other CP/M books don't even attempt this. Alan Miller makes it easy; his method is ingenious. As he explains the procedure, he has you go through all the steps without actually changing your BIOS. Then you save the unmodified BIOS, load it back onto the system tracks, and try to run it. If you followed all the steps, it will go just fine. However, if it doesn't, you know that you messed up the steps rather than the new driver routines you wrote.

In chapter 3 the author actually has you add new drivers to your BIOS. Again, Miller does the unusual. He assumes that anyone using this book will be proficient enough to write his own bare-bones routines. Therefore, Miller concentrates on adding bells and whistles to our programs. Instead of a simple printer driver, he shows you how to write printer-control and status-checking subroutines, how to use the IOBYTE to stream your output, and, finally, how to create a memory cache to direct your output to a disk file. If you're getting the idea by now that the software in this book is as valuable as the instruction, you're right.

Next, Miller starts to build a macro library. These subroutines are used repeatedly in assembly-language programming—for 16-bit arithmetic, screen control, disk manipulation, and more. Rather than rewrite these with every program, the programmer saves them on disk and then instructs his assembler to add them during assembly of his program. Unfortunately, ASM, the assembler that comes with CP/M, doesn't have the capability to use these. You must be using CP/M's Mac assembler to benefit from this section. If you're not, you'll quickly see why you need it to do any serious programming.

The next four chapters lead you through the intricacies of the high-level BDOS (basic disk-operating system) for both disk and nondisk uses. Again, you learn by writing yet more utility programs and macros. If you follow this through, you'll have written 24 macros and 15 complete programs. You'll have a disk full of utility programs and the knowledge to use them.

Now that you are proficient with BDOS, Miller leads you through the disk directory. You read not just the abbreviated form that the DIR command gives, you get all the nuts and bolts of the system including memory maps and disk parameters. Although CP/M is a fairly efficient system, it can be improved upon. By this point in the book, you're prepared to try to do just that.

Miller finishes with the mandatory listing of 8080 and Z80 mnemonics. Again, he can't stand to be conventional. His listings are followed by details of both instruction sets. Although it's definitely not a course in assembly-language programming for beginners, this book is also an excellent reference manual for advanced programmers. Again, Miller shows his knowledge of 8080 and Z80 programming by pointing out the similarities and the traps present.

Alan Miller has written a book aimed at the experienced programmer that will explain the ins and outs of the CP/M disk-operating system. By leading the reader by the hand without insulting him, by building up a macro library that will extend the raw CP/M system, and by demonstrating an intimate knowledge of the subtleties of CP/M, Miller's book is a worthy replacement for Digital Research's documentation. If I sound enthusiastic about this book, it's because I am.■

Bruce R. Evans (16 Marwin Rd., Pickering, Ontario L1V 2N7, Canada) is a family physician and an experienced CP/M user.

BYTE's Bugs

Line Change

Dean Brown of Alderwood Manor, Washington, spotted a bug in James Folts's IBM PC BASIC cross-reference utility (August, pages 378–384). The program will work properly with programs having 5-digit line numbers if line 6050 is changed from

```
6050
LABEL$(LABEL.NUMBER)
= SPACE$(5)
```

to

```
6050
LABEL$(LABEL.NUMBER)
= SPACE$(6)
```

Brown explains, "The change is necessary because the STR$(val) function used in line 6060 prefixes positive numbers with a blank, thus requiring the field length to be one greater than the length of the line number to be displayed."■

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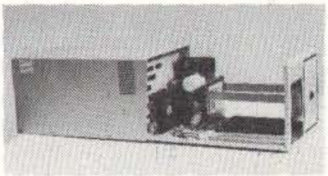
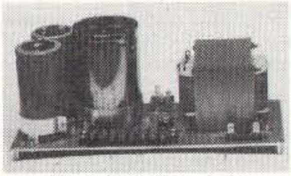
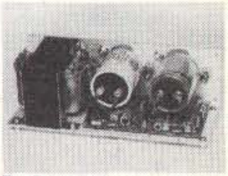


No. 806 & No. 516 Mainframes



Kit 1, 2 & 3 for S-100



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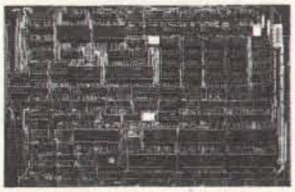

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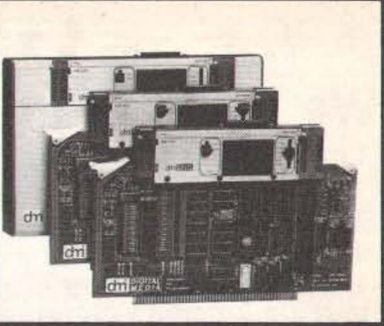

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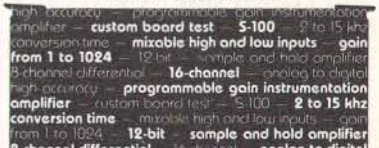
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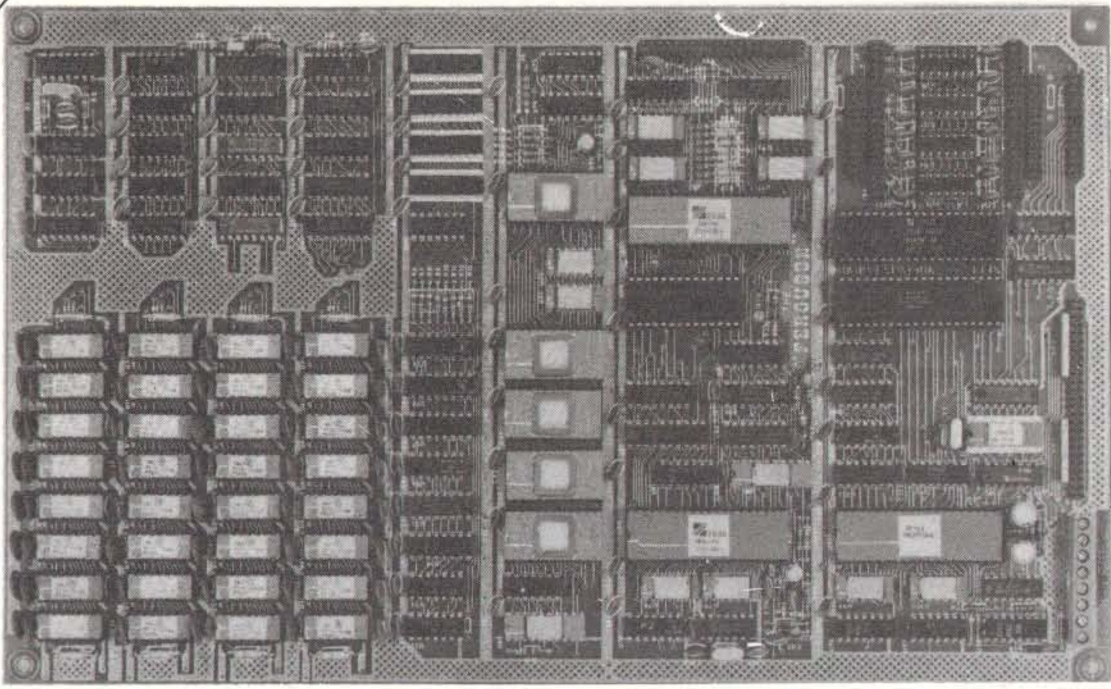

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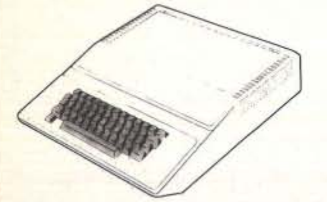

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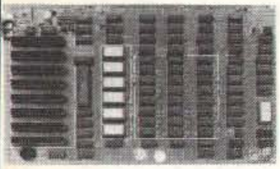

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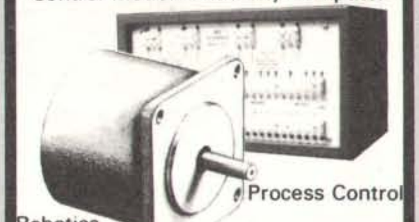

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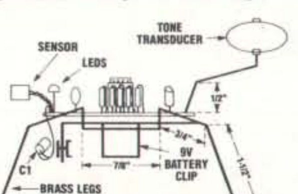

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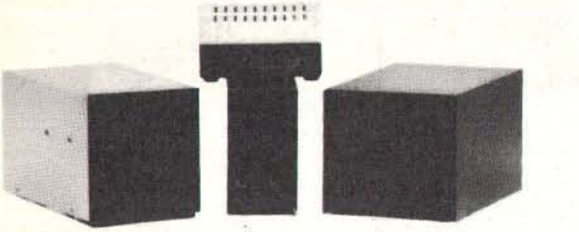

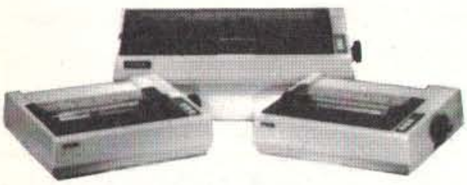

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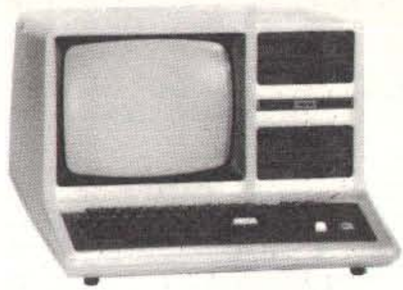

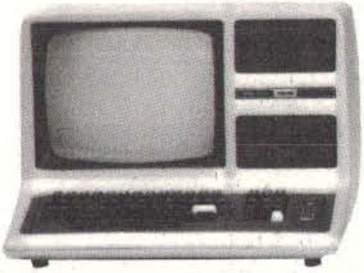

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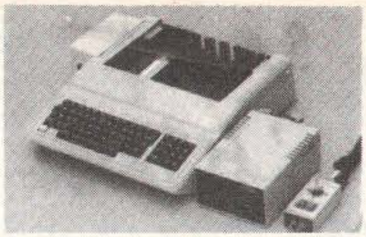

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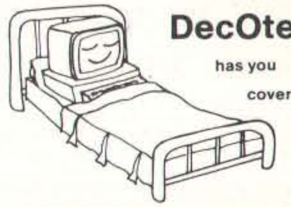

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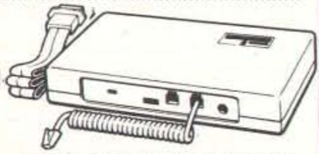

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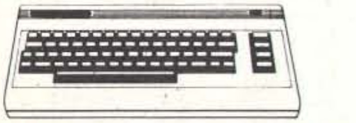

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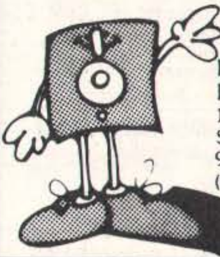

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    THEN                JNZ  L1
        A=A-14          SUI  14
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M(BC)=A;             L2:STAX B
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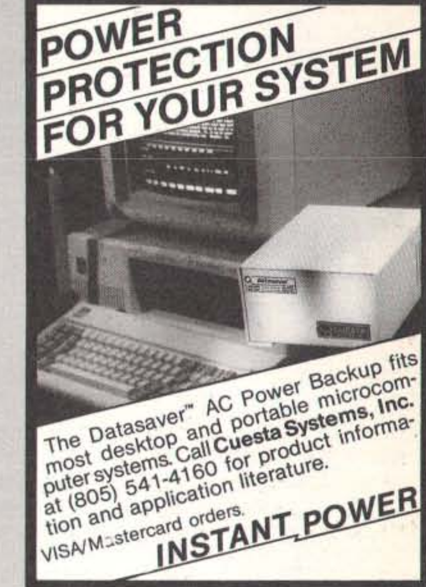

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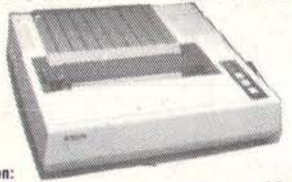

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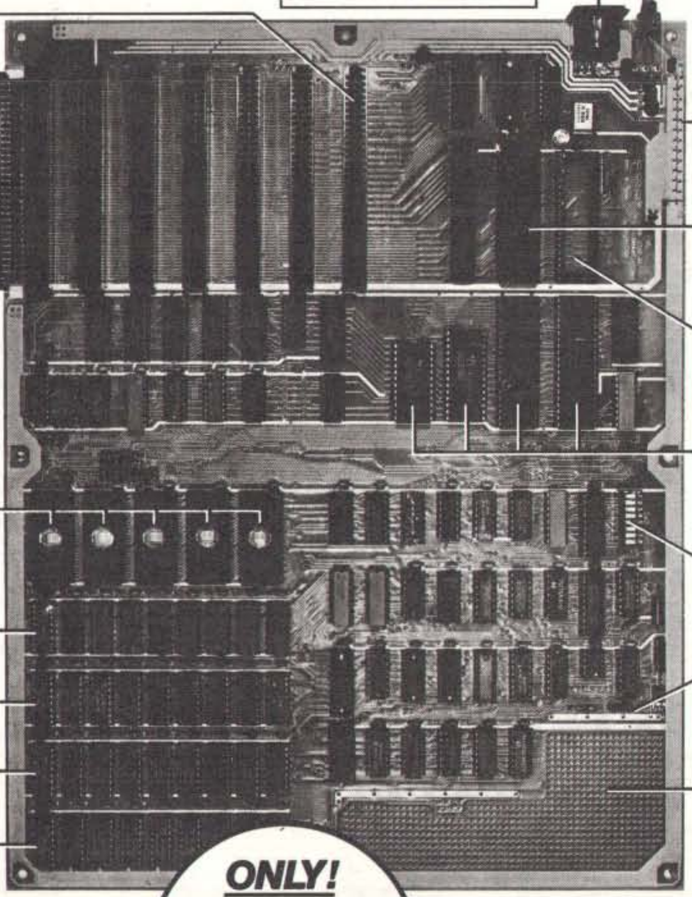

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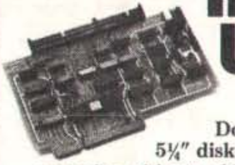

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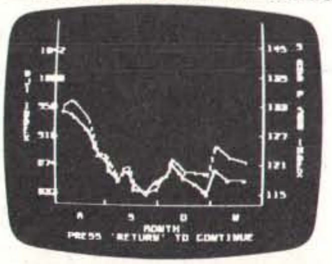

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TM101-4 (96 TPI Quad Den)	339.00
8" TM848-2 (DS/DD) 1.2 MG	400.00

SIEMAN'S

8" FD100-8 (SS/DD) 110V (801 R)	169.00
8" FD100-8 (SS/DD) 220V Compatible)	199.00

MPI

5¼" B-51 *40TR SS/DD* 180 K	145.00

CONNECTORS

RS232 Connectors

SOLDER TYPE

DB25P	2.50
DB25S	3.00
DB25 Hood	1.00
S-100 Connectors	10 for 25.00
DE9P	2,00

AC SURGE ELIMINATORS

Grizzly (200W) uninterruptible power system + surge protection	750.00
Grizzly (500W) uninterruptible power system + surge protection	1,802.00
Hawk AC power monitor w/surge protection	160.41
Lemon (6AC outlets-3 prong)	44.00
Lime (5'-3 prong pwr cord w/on-off switch	69.00
Orange-AC surge + EMI filter (6 outlets)	95.00
Peach (3 outlets)	69.00

DATA CABLES

8"DSC 88-2SKT-for 2-8" drvs w/skt. conn.	20.00
5¼"DSC55-2SKT-for 1-5¼" dvs w/skt. conn.	20.00
RS232MM-5' (male to male)	19.00
IBM to PAR	32.00
Osborne to PAR	32.00
Kaypro to PAR	32.00
OKI-Data Serial	24.00

E-PROM ERASERS

QUV-T8/1H (hobby)	49.95
QUV-T8/2I (Industrial version)	68.95
QUV-T8/2P (w/timer & safety switch)	97.50

DISK DRIVE CABINETS

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8" DDC88V28 w/PS vertical for 2-8" drives	269.00
8" DDC88T-1 w/PS vertical-for 2 or 4-8" thinline drives	269.00
8" DDC88T-2 w/PS vertical for 2 8" thinline drives	200.00
8" DDC8H w/PS horizontal for 1 ea. 8" drive	249.00
8" DDC8V w/PS vertical for 1 8" drive	249.00
8" DDC88H w/PS horizontal for 2-8" drives	269.00

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5¼" DDC5H w/PS horizontal-for 1-5¼" drive	55.00
5¼" DDC5V w/PS vertical-for 1 ea. 5¼" drive	65.00
5¼" DDC55V w/PS vertical-for 2-5¼ drives	85.00

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OUR BEST BUY'S

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DDS +O 2EA SS/DD Siemens FD100-8 Drives w/Cabinet	595.0
DDS +2 2EA DS/DD Mitsubishi M2894-63 w/cabinet	1,075.0
DDS +4 2EA DS/DD 8" Thinline Drives w/Cabinet	1,150.0

Specify—Vertical or Horizontal Cabinet

5¼" SUB ASSEMBLY

DDS +5 1EA SS/DD Disk Drive	200.0
DDS +6 2EA SS/DD Disk Drive	369.0

MODEMS

★Hayes Smart 300	199.00
★Hayes Smart 1200	499.00
Multi-Tech MT 212 AD (1200/300)	499.00
Novation J-Cat 300	119.00
U.S. Robotics 212A Auto Dial	469.00
★U.S. Robotics (300/1200)	375.00

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Dynax AM121 (20 MHZ) Hi-Res/80 Col/12"	139.0
USI PI-4 (20 MHZ) Hi-Res/80 Col/9"	139.0
USI PI-3 (20 MHZ) Hi-Res/80 Col/12"	149.0
★Zenith ZM122 (18 MHZ) Hi-Res/80 Col/12"	119.0

COLOR

Amdek I-12" Composite (For Apple)	260.0
Amdek II-12"-RGB (For IBM-PC) w/audio	469.0
Amdek I + Composite w/audio	289.0
BMC 9191-12" Composite (For Apple)	255.0
Princeton HX-12-RGB (For IBM-PC)	475.0
Sakata SC-100-13" Composite (For All)	260.0
Sakata SC-200-RGB (For All)	489.0

GREEN

BMC 12AU (15 MHZ) 80 Col/12"	80.0
Dynax GM 120 (20 MHZ) Hi-Res/80 Col/12"	129.0
Sanyo DM 2112 (15 MHZ) 64 Col/12"	80.0
Sakata SC-1000 (18 MHZ) 80 Col/12"	119.0
USI PI-1 (20 MHZ) Hi-Res/9"	129.0
USI PI-2 (20 MHZ) Hi-Res/12"	139.0

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AA-5¼ (Holds 82 Disks)	17.00
AA-8 (Holds 82 Disks)	26.00
Smoked Plexiglass Disk Tubs	

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Add $20.00 for 1 fan-Add $30.00 for 2 fans

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QTC-CCS-BB (S-100)	45.00
QTC-CCS-A (A + T) for S-100	95.00

MAINFRAMES

For 2 Standard 8" Drives

MF + DD6 (6 slot M/B)	575.00
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MF + 12 (12 slot M/B)	499.00
MF + 22 (22 slot M/B)	550.00

All mainframes except IMF + DD6F have EMI filter, 2 AC outlets, 15 ea. DB25, 2 ea. 50 pin, 2 ea. 34 pin, 1 ea. Centronic cutouts, power supply for 8" MF (–5V1A/ +5V6A/ +8V16A/ ±16V3A/ +24V6A)

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SDS-SBC-100-Z80 (4mhz) master 2 serial 2 par/floppy controller/64k ram	$655.00
SDS-SBC-100S4mhs slave/2 serial 2 par/64k ram	$565.00
SDS-ZSIO/4-4 serial port I/O bd	$250.00
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SDS-Turbodos-Multi-user for master & slaves	$645.00

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CPU 8086/8087	550.00
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M-Drive H	1,229.00
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630 (40CPS/Multi-IF)	1,790.00
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Diablo 630-Bi-Direct Tractor	275.00
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Franklin 1000 w/color	799.00
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Franklin 1200 OMS includes CPU-2 F.D. and bundled software	1,825.00

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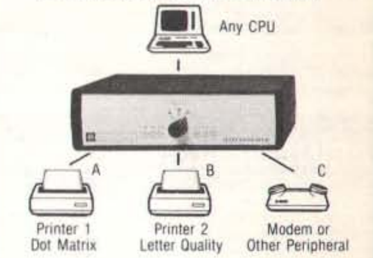

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RANA ELITE II W/CTRL	499.95
RANA ELITE III W/CTRL	649.95
SOUNDCHASER MUSIC SYSTEM	619.95
SOFTCARD (Z-80 CARD)	234.95
SWEET P PLOTTER	459.95
TG JOYSTICK W/TOGGLE IIe	49.95
TRANSMODEM 1200	499.95
WICO APPLE MOUSE	124.95

IBM

KOALA PAD TOUCH TABLET	99.95
KRAFT JOYSTICK	54.95
MICROSOFT SYSTEMCRD 256K	449.95
MICROSOFT MOUSE	134.95
MOUSE SYSTEMS PC MOUSE	224.95
QUADLINK APPLE EMULATOR	489.95
QUADRAM QUADBOARD I 64K	289.95
QUADRAM QUADCOLOR I	229.95
QUADRAM QUADCHROME MON	524.95
QUADRAM QUADSCREEN MON	1549.95
RANA DS/DD DISK DRIVE	259.95
STB SUPER I/O MULTIFUNCT	169.95
TG JOYSTICK W/TOGGLE	49.95
TRANSEND P.C. MODEM 1200	399.95
VERSAWRITER GRAPH TABLET	239.95
WIZARD SPOOLER P/S 16K	239.95

CBM-64 WARE

CARDBOARD/5 5 SLOT EXPAN.	54.95
CARDKEY/1	32.95
DATA20 Z80 VIDEOPAK	224.95
HES MODEM I	64.95
KOALA GRAPH TABLET W/SFT	79.95
VIC/64 SWITCH	119.95

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CALIFORNIA DIGITAL

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★ FREE ★

Plastic library case supplied with all diskettes purchased from California Digital

$19.95

Manufactured for California Digital by one of the most respected producers of magnetic media. Each diskette is double density at 40 tracks. To insure extended media life all diskettes are manufactured with a reinforced hub.

Each box of diskettes is supplied with a free plastic library case.

Soft sector CAL-501; Ten sector CAL-510.

Also Available Double sided soft sector diskettes for use with the IBM/PC

CAL-551 $24.95

5¼" DISKETTES WITH LIBRARY CASE

$26.50

Your Choice

SCOTCH
MEMOREX
VERBATIM

Single Side Double Density

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744D-0	744D-10	744D-16	26.50
MEMOREX	3481	3483	3485	26.50
VERBATIM	525-01	525-10	NA	26.50
MAXELL	MD1	MH1-10	MH1-16	26.50
DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	39.00
VERBATIM	550-01	550-10	NA	42.50
MAXELL	MD2-D	MH2-10D	MH2-16D	45.00
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

EIGHT INCH DISKETTES

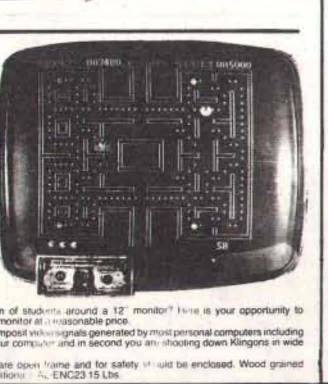
Single Side Single Density		
SCOTCH	740-0	29.50
MEMOREX	3060	29.50
DYSAN	3740/1	39.50
Thirty Two Sector		
SCOTCH	740-32	29.50

Single Side Double Density		
SCOTCH	741-0	39.00
MEMOREX	3090	35.00
DYSAN	3740/D	57.50
Double side Double Density		
SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

Flip & File 5¼" stores 50 disk.	INC-525	18.95
Flip & File 8" stores 50 disk	INC-800	22.85
Scotch head clean kit 5¼ & 8"	MMM-ck5	24.95
Plastic library cases 5¼ & 8"	SRW-L5	2.95

23" COMPOSITE MONITOR

$159



Ideal monitor for classroom demonstrations.

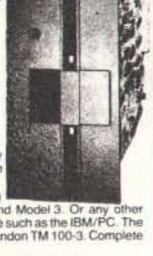
Ever try gathering a classroom of students around a 12" monitor? Here is your opportunity to purchase a 23" high resolution monitor at a reasonable price.

These units accept standard composit video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in second you are shooting down Klingons in wide screen video.

MOT-BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional. ENC23 15 Lbs.

SPECIAL

Shugart 410



$129

These Shugart 410 5¼" disk drives are all factory fresh 1983 production, recently purchased from the Four Phase Division of the Motorola Corporation.

These disk drives are **single sided 80 track**(96 TPI) suitable for use with the Radio Shack Model 1 and Model 3. Or any other application that can support an 80 track second drive such as the IBM/PC. The 410 is full height and functionally the same as the Tandon TM 100-3. Complete with power connector and installation manual.

When these Shugart 410's are liquidated the price will revert to our regular price of $249. SHU-SA410

MEMORY

16K DYNAMIC	2732 EPROM
1.95	4.95
4116 150ns.	450ns.
64K DYNAMIC	**16K STATIC**
5.95	4.95
4164 150ns.	6116 200ns.

2764 EPROM SALE $5.95

DYNAMIC MEMORY

		1-31	32 +	100 +
4027 4K dynamic 250ns.	ICM-4027250	1.99	1.85	1.75
4116 150ns. 16K	ICM-4116150	1.75	1.65	1.45
4116 200ns. 16K	ICM-4116200	1.75	1.65	1.45
4164 150ns. 64K 128 refresh	ICM-4164150	5.95	5.35	4.97
41256 150ns. 256K	ICM-41256150	Available	Mar.84	
DP8409 dynamic controller	ICT-8409	39.00	35.00	29.00
STATIC MEMORY				
21L02 200ns. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02 450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns. 2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257 300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	4.50	4.65	4.15
6116 P3 150ns. 2K x 8	ICM-6116150	4.75	4.55	4.35
6167 21[illegible] 100ns. 16K x 1 (20 pin)	ICM-6167100	7.95	7.50	7.90
EPROMS				
2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.50	4.25	3.97
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
2732 350ns. 4K x 8	ICE-2732350	8.50	8.00	7.60
2532 450ns. 4K x 8	ICE-2532	10.50	9.90	9.50
2764 350ns. 8K x 8	ICE-2764	5.95	5.65	5.35
27128 350ns. 16K x 8	ICE-27128	18.95	17.75	16.35
2817 EEROM. 2K x 8	ICE-2817	45.00	39.00	36.50

CONNECTORS

S-100 Gold

DB25P

GOLD S-100 EDGE CARD CONNECTORS

	catalog	each	10-99	100+
Imsai s/t .250"	CNE-IMS	2.95	2.50	2.19
Sullins Hi/Rel	CNE-H100	4.19	3.85	3.47
S-100 Wire W.	CNE-W10	3.95	3.50	3.19
Altair .140" s/t	CNE-100A	4.95	4.50	4.19

.156" CENTER EDGE CARD CONNECTORS

22/44 Eyelet	CNE-44E	2.50	2.15	1.95
43/72 Moto. s/t	CNE-72S	6.60	6.15	5.75
36/72 D/G s/t.	CNE-72S	5.95	5.50	5.19

Other connectors available upon request.

RIBBON CONNECTORS

DB25P male	CND-r25P	5.65	5.25	4.15
DB25S female	CND-r25S	5.95	5.59	4.50
57-30360 male	CNC-r36P	7.95	6.75	5.90
57-30360f male	CNC-r36S	7.95	6.75	5.90
20 pin edge	CNI-DE20	4.35	3.30	2.50
20 pin socket	CNI-DS20	2.75	1.85	1.60
26 pin edge	CNI-DE26	4.95	3.50	2.70
26 pin socket	CNI-DS26	3.50	2.40	2.15
34 pin edge	CNI-DE34	4.95	4.50	3.50
34 pin socket	CNI-DS34	4.50	3.95	3.15
50 pin edge	CNI-DE50	5.95	5.60	4.90
50 pin socket	CNI-DS50	4.95	4.60	3.80

"D" TYPE	catalog	each	10-99	100+
DE9P male	CND-9P	1.60	1.40	1.30
DE9S female	CND-9S	2.25	2.00	1.30
DE hood	CND-9H	1.50	1.35	1.20
DA15P male	CND-15P	2.35	3.10	2.90
DA15S female	CND-15S	3.25	3.10	2.90
DA15 hood	CND-15H	1.60	1.35	1.30
DB25P male	CND-25P	2.50	1.95	1.65
DB25S female	CND-25S	3.35	2.75	1.95
DB25 hood	CND25H	1.35	1.15	.77
DC37P male	CND-37P	4.20	3.95	3.65
DC37S female	CND-37S	5.95	5.75	5.50
DC37 hood	CND-37H	2.25	1.95	1.65
DD50P male	CND-50P	5.50	5.10	4.75
DD50 hood	CND-50H	2.60	2.40	2.10
Hardware 2/set	CND-2HS	.99	.69	.42

AMPHENOL / CENTRONICS TYPE

57-30360 36/P	CNC-36P	7.95	6.35	4.90
IEEE488. C'dor	CND-24P	7.95	6.35	5.35

DISK DRIVE POWER CONNECTORS

8" 6 pin D.C.	CNP-6DC	1.95	1.29	.89
8" 3 AC Sgl/S	CNP-3SS	1.69	1.09	.69
8" 3 AC Dbl. S	CNP-3DS	1.69	1.09	.69
5¼" 4 pin D.C.	CNP-4DC	1.79	1.19	.99
3 pin DIN recpt.	CNP-D3P	2.59	1.99	1.59

BLOWOUT SALE

$169

California Digital has recently participated in the purchase of several thousand Siemens FDD 100-8 floppy disk drives. These units are electronically and physically similiar to that of the Shugart 801R. All units are new and shipped in factory sealed boxes. Manual and power connectors supplied free upon request. Your choice 115 Volt. 60 Hz. or 230 Volt. 50Hz.

NOTE! European customers, we have a large quantity of 230 volt 50 Hz. units warehoused in Frankfort Germany. Arrangements can be made to will call these drives in quantities of 50 or more in Frankfort reducing import duty and freight charges.

REMEX DOUBLE SIDED $219

California Digital has just purchased a large quantity of Remex RFD-4000 **Eight inch double sided** disk drives. Remex is the only double sided disk drive that has an double gimbal mounted head assembly that guaranties lower head tracking. This drive is mechanically solid. Remex has always been known for producing premiere products for the floppy disk market. The Remex company is a subsidiary of the Ex-cell-o Corporation, a Fortune 500 Company.

Eight Inch Single Sided Drives

	One	Two	Ten
SHUGART 801R	385	375	365
SHUGART 810 Half Height	385	375	365
SIEMENS FDD 100-8	169	169	159
TANDON 848E-1 Half Height	369	359	349

Eight Inch Double Sided Drives

SHUGART SA851R	495	485	475
SHUGART 860 Half Height	485	475	459
QUME 842 "QUME TRACK 8"	459	459	449
TANDON 848E-2 Half Height	459	447	465
REMEX RFD-4000	219	219	209
MITSUBISHI M2894-63	379	375	369
MITSUBISHI M2896-63 Half Ht.	459	449	409

Five Inch Single Sided Drives

SHUGART SA400L	235	229	225
SHUGART SA410 96TPI/80 Trk.	129	119	call
SHUGART SA200 ⅔ Height	159	149	139
TANDON TM100-1	189	179	175

Five Inch Double Sided Drives

SHUGART SA450	319	309	299
SHUGART SA455 Half Height	259	249	239
SHUGART SA465 Half Ht. 96TPI	289	279	269
TANDON TM50-2 Half Height	215	209	199
TANDON TM55-4 half Ht. 96TPI	329	319	309
TANDON 100-2	279	269	259
TANDON 101-4 96TPI 80 Track	369	355	350
MITSUBISHI 4851 Half Height	259	249	245
MITSUBISHI 4853 ½ Ht. 96TPI	339	329	319
MITSUBISHI 4854 ½ Ht., 8" elec.	465	449	439
QUME 142 Half Height	239	229	219
TEAC FD-55B Half Height	299	389	275

Five Inch Winchester Hard Disks Drives

SHUGART 612	13 M/Bytes	895	865	825
SHUGART 706	6 M/Byte, Half Ht	795	775	755
SHUGART 712	13 M/Byte, ½ Ht.	895	865	825
SEAGATE 506	6 M/Byte	495	475	455
TANDON 503	19 M/Byte	895	875	855

Upon request, all drives are supplied with power connectors and manual

ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an enclosure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

Horizontal mount two 8" full height drives. $279.00

Vertical mount two full height 8" disk drives. $299.00

Horizontal mount one full height or two half height 8" disk drives. $239.00

Vertical mount two full height 5¼" disk drives. $139.00

VISA

master charge

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. ● COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.
Retail location: 15608 Inglewood Avenue, Lawndale 90260.

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TECHNICAL & CALIFORNIA
(213) 643-9001

California Digital

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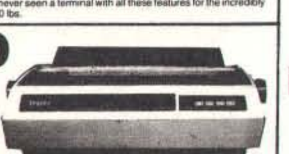
LIBERTY FREEDOM 50 $475

The Liberty Freedom 50 terminal features detachable keyboard with 93 keys including 10 function keys, 15 graphic symbols, and DIP switch selectable character set for 7 foreign languages. The 12 inch etched non-glare green phosphor screen displays 24 rows by 80 characters in 7x9 matrix with true descenders. Self test and 25th data display row also included. Switch selectable baud rates from 110-19,200 baud. Screen attributes do not use display memory, allowing operator to display a full 1920 characters. Emulates 5 popular CRT terminals for easy software configuration. Switch selectable between 115 and 230 volt. We have never seen a terminal with all these features for the incredibly low price of only $475. LIB-F50 40 lbs.

DIABLO

Word Processing Printer

$879



Now from the originator of the daisy wheel printer, the Diablo 620. Print speeds to 24 char/sec. user selectable bi-directional printing, superscripts, subscripts, graphics and more. Plus standard RS-232 interfacing. Communication speeds to 1200 baud with a 1500 character print buffer. Software programable absolute horizontal tabs makes report formatting easy. Over 20 different print wheels are currently available. The 620 automatically selects the print spacing for 10, 12, 15 char/inch print wheels. On site service available worldwide. DBL-620 50 lbs.

FREE

Your Choice
Second Drive or Monitor

SANYO

IBM COMPATIBLE

$995

Sanyo Electronics has just released the long awaited IBM/PC look-a-like, the MBC-550. This is a complete microcomputer that includes 128K/byte of memory, a 5¼" 160K/byte disk drive upgradeable to 320K/byte drives. Also includes both color composite and RGB graphics interface, low profile keyboard, and parallel printer port. Extensive software such as Sanyo Basic, disk utilities, Wordstar word processing software, Calcstar spread sheet & Easy Writer I. MS-DOS is supplied with the Sanyo computer. Most programs written for the IBM/PC will operate on the MBC-550.

Along with all this California Digital offers "FREE" your choice of either a second disk drive, or a high resolution green or amber screen monitor. All at the super low price of only $995.

We are currently experiencing an initial shortage of this computer. Please place your orders early. The MBC-550 will be shipped on a first ordered basis.

PRINTERS

$289 Star Gemini

MATRIX PRINTERS

Star Gemini-10X 120 char/sec. 4K buffer.	STR-G10X	289.00
Star Gemini-15, 100 char./sec. 15" paper.	STR-G15	385.00
Star Gemini Delta 10, 160 Char/sec	STR-D10	439.00
Star Coex 80FT friction & tractor	VST-C80FT	229.00
Toshiba P1350, 192 char/sec. letter quality	TOS-1350	1469.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	379.00
Okidata 92A parallel interface, 160 char/sec.	OKI-92A	479.00
Okidata 83A & parallel 15" paper	OKI-83A	619.00
Okidata 84A & parallel 15" paper	OKI-84A	1024.00
Okidata 2350 (new) 350 char/sec	OKI-2350	1995.00
Epson FX80, 10" 160 char./sec. with graphtrax	EPS-FX80	575.00
Epson MX100 with graphtrax, 15" paper	EPS-MX100	645.00
NEC8023A parallel 9½" paper, graphics	NEC-8023A	389.00
Anadex 9501A high speed with graphics	ADX-9501A	1099.00
Anadex 9620A 200 char/sec. par'l & serial.	ADX-9620A	1199.00
Quantex 7030 corespondence quality 180 char/sec.	QTX-7030	1595.00
Gorilla low cost dot matrix printer	PRO-7500	189.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	343.00
Prowriter II, parallel 15" paper, graphics	PRO-2P	689.00
Dataproducts B-600-3, band printer 600 LPM.	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute.	PTX-P300	4250.00
Printronix P600 ultra high speed 600 lines per minute.	PTX-P600	5795.00
Mannesmann Tally 160L serial & par'l, 160 char/sec.	MAN-160L	559.00

WORD PROCESSING PRINTERS

NEC7710 55 char/second, serial interface	NEC-7710	1939.00
NEC7730 55 char/sec. par'l interface.	NEC-7730	1939.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1799.00
NEC2050 designed for IBM/PC 20 char/sec. par'l	NEC-2050	995.00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	459.00
Silver Reed EXP550 17 Char/sec par'l interface.	SRD-EXP550	659.00
Diablo 630 40 char/sec. serial	DBL-630	1765.00
Diablo 620, proportional spacing, horz.& vert. tab. 20 cps.	DBL-620	879.00
Juki 6100, 18 char./sec. graphic mode	JUK-6100	539.00
Brother HR1A daisy wheel, parallel interface	BTH-HR1P	695.00
Brother HR1A serial interface	BTH-HR1S	779.00
Starwriter F10 serial, 40 char/sec	PRO-F10S	1125.00
Starwriter F10 parallel, 40 char/sec.	PRO-F10P	1125.00
Comrex CR1 word processing printer, serial intr.	CRX-CR1S	729.00
Comrex CR2, 5k buffer, proportional spacing, par'l.	CRX-CR2P	495.00

MONITORS

BMC 12A green phosphor 15 MHz. composit video.	BMC-12A	79.00
BMC 12" high resolution, 20MHz.	BMC-12EN	134.00
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	119.00
Zenith ZVM123 green phosphor 12" 40/80 column switch.	ZTH-Z123	105.00
NEC JB1201 green phosphor 18 MHz. composit video.	NEC-JB1201	169.00
NEC JB1260 commercial grade composit.	NEC-JB1260	129.00
USI Amber screen 12" composit monitor.	USI-12A	169.00
Motorola 23" open frame blk/white composit video.	MOT-BW23	159.00
Motorola 12" open frame requires horz sync. and power.	MOT-BW12	69.00
Conrac 9" open frame requires horz sync. & 12v. supply	CON-BW9	59.00
COLOR		
BMC AU9191U Color composit video with sound	BMC-9191	249.00
BMC 9191M RGB designed for use with the IBM computer.	BMC-9191M	499.00
NEC JC1203DM RGB color monitor	NEC-1203	699.00
NEC JC1201 color composit.	NEC-JC1201	339.00
Zenith ZVM134 RGB color suitable for IBM PC	ZTH-Z134	379.00
Comrex color composit with sound	COM-6500	329.00
Amdek Color 1, composit video	AMK-100	329.00

MODEMS

DIRECT CONNECT
$69

Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	474.95
Hayes 1200B for use with the IBM/PC, 1200 baud.	HYS-1200B	449.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Micromodem 100, S-100 auto answer, auto dial.	HYS-100	319.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
U.S. Robotics 212A 300/1200 baud, auto dial/answer.	USR-212A	439.00
Penril 300/1200 auto dial,autolog	PEN-12AD	695.00
Universal Data 103LP, line power, answer & originate.	UDS-103LP	169.00
Universal Data 103LPJ, Auto answer	UDS-103LPJ	219.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00
Novation 'J' Cat, direct connect, auto answer	NOV-JCAT	115.00
Novation Cat, acoustic connect	NOV-CAT	159.00
Novation SmartCat 103, auto answer, auto dial	NOV-SC103	219.00
Novation SmartCat 103/212, 1200 baud auto dial	NOV-SC212	529.00
Signalman Mark 1, direct connect with terminal cable.	SGL-MK1	69.00

TERMINALS

The Wyse 100 features die cast aluminum case, 102 key keyboard and non-glare 26 line green phosphor video display. Split screen both horizontal an vertical makes the WY-100 unusally user friendly. This unique terminal is perfect to enhance any business system.

$795

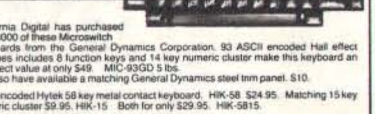
Freedom 50, split screen, detatchable keyboard	LIB-F50	475.00
Visual 50, detatchable, keyboard selectable settings.	VSL-50	619.00
Visual 50 Green screen	VSL-50G	650.00
Visual 330, emulator, 14 inch green phosphor.	VSL-33014G	925.00
Ampex Dialogue 125 green screen, two page, func. keys	APX-D125G	675.00
Ampex Dialouge 125 amber screen, two page, func. keys	APX-D125A	685.00
Wyse 50, 14" green phosphor	WYS-50	595.00
Wyse 100, horz & vert. split screen, metal enclosure	WYS-100	795.00
Wyse 300, Eight color display, split screen.	WYS-300	1159.00
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759.00
Televideo 950, graphic char., split screen, 22 func.	TVI-950	950.00
Televideo 970, 14" green screen, 132 column, European	TVI-970	1095.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00

APPLE

$989

Apple II/e, 64K computer only	APL-2E	$989
Apple II/e starter kit, monitor, disk, 80 col. card.	APL-2ESK	1495
Advanced Busness Tech. 13 Key Pad	ABT-13B	109
Calif. Computer 7710A Async. Serial Interface	CCS-7710	125
Calif. Computer 7710B same but for modem	CCS-7710B	125
Calif. Computer 7114A 12K PROM module	CCS-7114	99
Calif. Computer 7720A parallel interface	CCS-7720	99
Calif. Computer 7724A Calandar/clock modual	CCS-7724	99
Calif. Computer 7729A Centronics interface	CCS-7729	99
Calif. Computer 7740A programmable timer	CCS-7740	99
California Digital 16K card for standard Apple II	CAL-A16	39
Hayes Micromodem II for Apple II	HYS-MM2	279
Kensington Micro, System saver fan	KEN-SF1	75
Microsoft Softcard with CP/M; Z-80	MSF-SFTCD	239
Mountain Computer "The Clock"	MTN-TCLK	225
Mountain Computer AD/DA 16 input, 8bit	MTN-ADDA	269
Mountain Computer ROM Plus with keybb. filter	MTN-RMF	169
Mountain Computer ROM writer/socket socket	MTN-ROMW	139
Orange Micro "GRAPPLER" parallel interface	OMS-G2	135
Sorrento Valley 8" controller double side D/D.	SVA223	395
TEAC 5¼" disk drive for Apple II	TEA-A2	269
Vista Vision 80; 80 column card for std.Apple II	VSA-VIS80	289
Vista 8" disk controller double side D/D.	VSA-A800	489

ASCII KEYBOARD $49



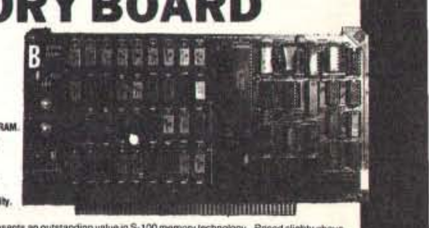
California Digital has purchased over 3000 of these Microswitch keyboards from the General Dynamics Corporation. 93 ASCII encoded Hall effect switches includes 8 function keys and 14 key numeric cluster make this keyboard an excellect value at only $49. MIC-93GD 5 lbs.
We also have available a matching General Dynamics steel trim panel. $10.

Non-encoded Hytek 58 key metal contact keyboard. HIK-58 $24.95. Matching 15 key numeric cluster $9.95. HIK-15 Both for only $29.95. HIK-5815.

Not pictured. 49 key eight bit modified Hollerith coded Microswitch Hall effect keyboard. REMOVED from punch card equipment. $14.95 DIT-KB49 ASCII encoder available.

256 KILOBYTE MEMORY BOARD

$495



- **256 kilobytes of memory using 64K dynamic RAM.**
- **Over one megabyte of memory using the new 256K dynamic RAM chips.**
- **Error detection-trap capability.**
- **Individual 16K block can be relocated to any boundry within a megabyte of RAM.**
- **24 bit addressing and phantom mode capability.**

The California Digital 256K RAM board represents an outstanding value in S-100 memory technology. Priced slighty above earlier generation 64K dynamic ram boards it gives you these additional features. 256K of memory with parity. Parity error feature can be jumpered to any of the interrupt lines, a status port, ERROR LED, or IEEE-696 *ERROR signal. 24 or 16 bit addressing with memory management.
Proper operation with front panel equipped systems, DMA disk controllers, and IEEE-696 Temporary Buss Masters assured with an on the board M1 generator for memory refresh timing. CAS and RAS timing is controlled with tapped digital delay lines for proper operation over the entire operating temperature range.
The board is very recent in design using the National Semiconductor DP-8409 RAM Controller chip. Split termination networks are used on all address lines, CAS line, and RAS lines eliminating the last traces of ringing. The board uses two separate voltage regulators. One for the DRAMs and one for the interface logic increasing the noise immunity of the ram array. Typical power dissipation is 8 watts.
Documentation includes theory of operation, configuration guide, a schematic, and application notes on the use of the memory management options. CAL-256K 2 Lbs.

S-100 BOARDS

16 BIT MICROPROCESSORS

Octagon dual CPU 8088/Z80, & controller.	OCT-88Z80	795.00
Godbout 8086/8087 microcomp. 16 bit.	GBT-8687	495.00
Godbout dual processor 8085/8088, 8/16	GBT-8588	359.00

SINGLE BOARD COMPUTERS

Insight ED-4, 128K, 4 serial "not S-100"	INS-ED4	595.00
Advanced Digital, Floppy & 64K	AMD-Z80	750.00
Teletek System master, 765 floppy, 64K.	TEL-SM1	895.00
Teletek FDC-1 single board, no memory	TEL-FDC1	675.00

8 BIT MICROPROCESSORS

Godbout Z80, 24 bit extended add.	GBT-Z80	250.00
California Computer Z80 microprocessor	CCS-2810	275.00
Tarbell Z80 with two RS232 ports	TAR-Z80	339.00

FLOPPY DISK CONTROLLERS

Godbout Disk 1, double density.	GBT-DSK1	395.00
California Computer 2422A with CPM	CCS-2422	339.00
Morrow Disk Jockey II with CPM 2.2	MDS-DJ2	350.00
Morrow Disk Jockey I with CPM, sgl. Den.	MDS-DJ1	225.00
Tarbell Electronics double density	TAR-DDC	419.00
Tarbell Electronics single density	TAR-SDC	279.00
Fulcrum DMA OmniDisk, I/O to hard disk	FCM-OD1	389.00

CPM OPERATING SYSTEM

Digital Research CP/M 3.0, 8" sgl. den.	DRC-CpM30	249.00
Godbout CPM 2.2 for Disk 1.	GBT-CpM22	159.00
Godbout CPM85 for 8088 and 8086	GBT-CpM85	265.00
Tarbell Electronics CPM 2.2	TAR-CpM22	159.00

HARD DISK CONTROLLERS

Octagon hard disk controller with E/C.	OCT-HD1	475.00
Godbout Disk 2, 8" & 14" hard disk	GBT-DSK2	569.00
Godbout Disk 3, for 5¼" Winchesters	GBT-DSK3	Nov.
Morrow Designs controller for 5¼" Win.	MDS-W506	495.00
Western Digital new WD-1001 (not S-100)	WDI-1001	495.00

EPROM BOARDS

Inner Access EPROM Bd. programs 27128	IAC-P100	465.00
Digital Research PROM board, 32K	DGR-P32	119.00

STATIC MEMORY BOARDS

Godbout Ram 16, 64K 16 bit data trans.	GBT-R16	459.00
Godbout Ram 17, 64K 8 bit 24 bitaddress	GBT-R17	359.00
Godbout Ram 21, 128K byte 8/16 transfer	GBT-R21	859.00
Fulcrum OmniRam 8/16 transfer bank.	FCM-R816	395.00
California Computer 2116, 8 bit only.	CCS-2116	249.00

DYNAMIC MEMORY BOARDS

California Digital 256K expand to 1 Meg	CAL-D256	495.00
California Comp. 2066, 64K bank select	CCS-2066	295.00

INTERFACE BOARDS

Godbout Interfacer I, 2 serial ports	GBT-133A	239.00
Godbout Interfacer II, 1 serial 3 par'l ports	GBT-150A	269.00
Godbout Interfacer III, with 5 serial ports	GBT-135A	495.00
Godbout Interfacer III, with 8 serial ports	GBT-138A	585.00
Godbut Interfacer IV, 3 serial, 2 parallel	GBT-187A	329.00
California Computer 2710, 4 serial ports	CCS-2710	279.00
California Computer 2719, 2 serial, 2 par'l.	CCS-2719	295.00
California Computer 2720, 4 port par'l.	CCS-2720	219.00
California Computer 2830, 6 port serial	CCS-2830	429.00
Morrow Designs Multiboard, 3 S/2P.	MDS-MTL1	319.00

SPECIAL FUNCTION BOARDS

Hayes S-100 Micromodem, 300 baud.	HYS-M100	325.00
QT Computer clock calendar, battery	QTC-CC100	139.00
Godbout System support board, 4K EPROM	GBT-SYS1	350.00
Godbout System support board, 9511 math	GBT-S9511	539.00
Dual Systems, 4 channel 12 bit D/A conv.	DSC-AOM12	619.00
Dual System 12 bit resolution, 32 ch. A/D	DSC-AIM12	629.00
Mullins Opto-Isolator, controls 8 ch.	MUL-ICB10	179.00
Mullins extender board with logic & probe	MUL-TB4	79.00
I/O Technology wire wrap prototype	IOT-W100	49.00
Artec Electronics wire wrap prototype	ART-WW100	25.00
Artec Electronics general purpose solder	ART-GP100	25.00

MAINFRAMES & MOTHER BOARDS

Eclipse Data, stainless, 22 slot	EDP-100	695.00
Godbout Enclosure 2, 20 slots	GBT-MF2D	675.00
California Computer 2200, 12 slot	CCS-2200	479.00
California Digital 18 slot mother board	CAL-MB18	35.00
Godbout 12 slot mother board assembled	GBT-MB12	149.00

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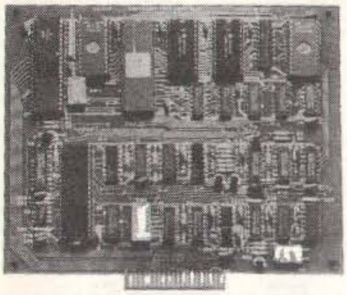
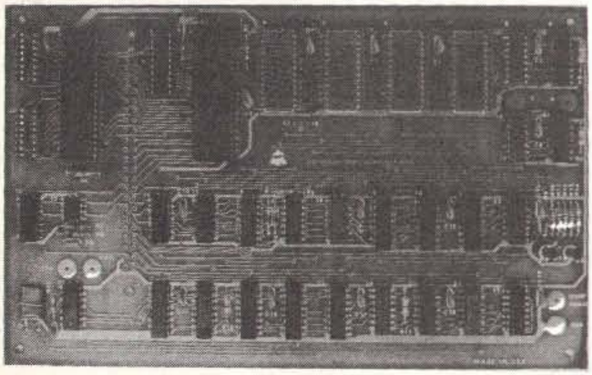


VIDEO TERMINAL BOARD. This is a complete stand alone Video Terminal board. All that is needed besides this board is a parallel ASCII keyboard, standard NTSC monitor, and a power supply. It displays 80 columns by 25 lines of UPPER and lower case characters. Data is transfered by RS232 at rates of 110 to 9600 baud—switch selectable. Complete source listing is included in the documentation. Both the CRT program and the character generator are in 2716 EPROMS to allow easy modification to your needs. This board uses a 6502 microprocessor and a 6845 crt controller. The serial input port is interrupt driven. Assembled and tested part number 82-018A **$199.95.** The bare board with the crystal and EPROMS, part number 82-018B **$89.95**



MINI VIDEO. This board can be used to add a video display to your aim or other computer. It can also, with the addition of a parallel keyboard, 5V power supply, and video monitor, run Tom Pittman's Tiny Basic. The display format is 40 columns by 24 lines. This board has two parallel ports (6522), a 6502 MPU 4K RAM, 2 or 4K EPROM. The assembled video board without EPROMS, part number 82-140A **$149.95.** The Tiny Basic EPROM **$39.95.** The character generator EPROM **$19.95.** The parallel input EPROM **$19.95.**

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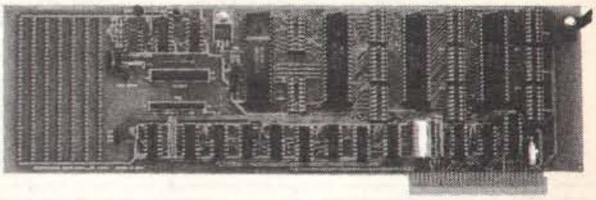
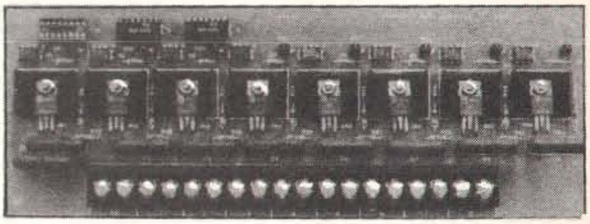
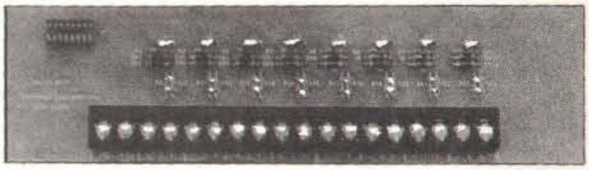


UNIVERSAL I/O. The Universal I/O board has 16 eight bit analog inputs with a voltage range of 0 to 5 volts. It also has 9 eight bit parallel I/O ports. It has interrupt circuitry, Timer clock 32768 Hz. to 512 sec., prototyping area, and LED for power. Part number 83-064A **$299.95**



120 VAC CONTROL. This board has eight optically isolated triac switches. Each switch can control 200 watts. It connects via a 16 pin ribbon cable to a parallel output port. Screw terminals are provided for 120 vac connection. Part number 82-332. **$119.95.**



INPUT PROTECTOR. This board protects the inputs of the ANALOG input or PARALLEL input ports. There are 4.7K pullups, diodes and caps for each line. It connects via a 16 pin ribbon cable. Screw terminals are provided for connection. Part number 82-334. **$89.95.**

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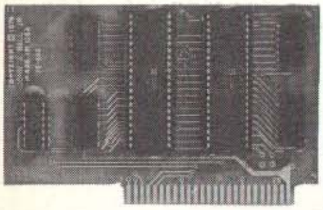
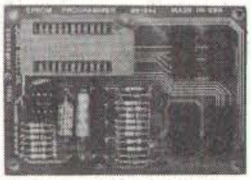
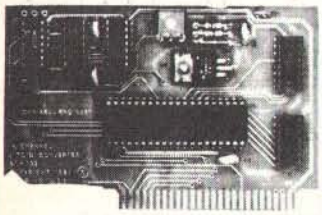


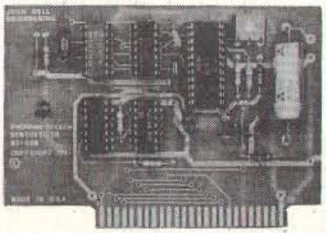
6522 APPLE II INTERFACE. This interface plugs directly into slot 1 through 7 in the APPLE II or the APPLE IIe. It provides four 8 bit bi-directional I/O ports, four 16 bit timer/counters, and handshaking. Four 16 pin dip sockets provide easy connections to peripheral devices. This board is also used to run the JBE EPROM Programmer. Order part # 79-295A assm. **$69.95** or # 79-295B bare board **$29.95**



EPROM PROGRAMMER. Programs 5 volt 2716's, 2516's, and 2532's. It interfaces to the 6522 interface with 4 ribbon cables. A Textool zero insertion force socket is used for the EPROM. Complete documentation for reading and writing. Cables available separately. Order part # 80-244A assm. **$49.95** or # 80-244B bare board **29.95** and set of 4 cables 2 ft. long **$17.00**



A-D CONVERTER. 16 Channel A-D plugs into your APPLE II or APPLE IIe. The 16 inputs are high impedance, 0 to 5 volt range, 8 bit resolution. Conversion time is less than 100 us per channel. Two 16 pin dip sockets are used for input. Order part # 81-132A assm. **$89.95** or # 81-132B bare board **$29.95**



SPEECH SYNTHESIZER. This board uses the VOTRAX SC-01 Phoneme Synthesizer chip. The on board audio amp connects directly to an 8 ohm speaker. A disk with a text to speech program is included. Order part #81-088 **$129.95**

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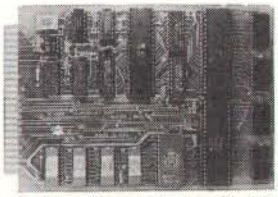
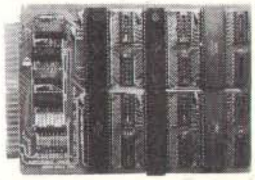
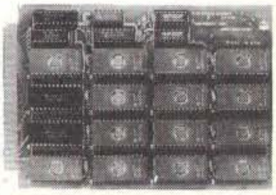


SLIM MICROCOMPUTER. This 6502 based 4.5″ × 6.5″ computer has the same 44 pin bus as the AIM computer. It has 2K RAM, 2K or 4K EPROM, and four 8 bit parallel I/O ports (two 6522's). The clock is 1 MHz crystal controlled and has power on reset. This board was designed for control and is ideal for personal and OEM use. This computer can be expanded with the peripherals listed below. Order part # 81-260A assm. **$199.95** or #81-260B bare board **$39.95**

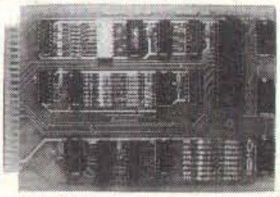
SIX SLOT MOTHER BOARD. This board has 6 44 pin edge connectors connected in parallel. The card spacing is .750″. It will mount in VECTOR card cages. Order part # 81-320A assm. **$99.95** or # 81-320B bare board **$49.95.**



12 PORT PARALLEL I/O. This board has six 6522 VIA's. This is a total of 96.I/O lines. Each of the 12 8 bit ports also has 2 handshake lines. Order part # 82-036A assm. **$169.95** or # 82-036B bare board **$49.95**



RAM EPROM MEMORY (32K). This board has 16 24 pin sockets that will accept 2716 EPROM's or 6116 RAM's to total 32K bytes. The memory is mapped from 0 to 7FFF. The first 2K (0-7FF) can be disabled with a jumper to allow for the 2K of RAM on the SLIM computer. Order part # 81-330A assm. w/o memory **$99.95** or # 81-330B bare board **$49.95**



ANALOG I/O INTERFACE. This board has 16 analog inputs and 2 analog outputs. The inputs are 8 bit (256 steps), 0-5 volt, high impedance with a conversion time of 200us per channel. The outputs are R-2R ladders (R = 15K) driven between 0 and 5 volts and are 8 bit (256 steps) also. Order part # 81-292A assm. **$199.95** or #81-292B bare board **$49.95**

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SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	1.25
SN7444N	16	1.25
SN7445N	16	.69
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SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459N	14	.25
SN7460N	14	.39
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Part No.	**Pins	Price
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.89
SN7482N	14	1.49
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.79
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.89
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	3.25
SN74100N	24	1.95
SN74104N	14	1.19
SN74105N	14	1.19
SN74107N	14	**.29**
SN74109N	16	**.39**
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.69
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.89
SN74142N	16	3.95
SN74143N	24	3.95
SN74144N	24	3.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59

Part No.	**Pins	Price
SN74156N	16	.59
SN74157N	16	**.59**
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.95
SN74170N	16	1.29
SN74172N	24	4.95
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SN74174N	16	.69
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SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	1.19
SN74184N	16	2.49
SN74185N	16	2.49
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	2.49
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

74LS00	14	.25
74LS01	14	.25
74LS02	14	.29
74LS03	14	.25
74LS04	14	.35
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	**.29**
74LS26	14	.29
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74LS32	14	.39
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74LS42	16	.55
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74LS86	14	.39
74LS90	14	.55

74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.89
74LS125	14	.59
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.89
74LS139	16	.79
74LS151	16	.59
74LS153	16	.59
74LS154	24	1.29
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.69
74LS175	16	.69
74LS181	24	2.95
74LS190	16	.89
74LS191	16	.89

74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.49
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.49
74LS374	20	1.49
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S85	16	2.49
74S86	14	.55
74S112	16	.55
74S113	14	.55

74S114	14	.55
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	1.19
74S175	16	1.19
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49

74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	1.19
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

CA3010H		1.35
CA3039H		1.35
CA3046N	14	1.35
CA3059N	14	2.95
CA3060N	16	2.95
CA3065E	14	1.49
CA3080E	8	.89

CA3081N	16	.99
CA3082N	16	1.19
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.49

CA3130E	8	.89
CA3140E	8	.79
CA3160H		1.95
CA3162E	16	6.95
CA3189E	16	1.59
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

CD4000	14	.29
CD4001	14	**.29**
CD4002	14	.29
CD4006	14	1.19
CD4007	14	.29
CD4009	16	**.59**
CD4010	16	.59
CD4011	14	.29
CD4012	14	.29
CD4013	14	.39
CD4014	16	1.19
CD4015	16	**.39**
CD4016	14	.49
CD4017	16	1.19
CD4018	16	.99
CD4019	16	.59
CD4020	16	1.19
CD4021	16	1.19
CD4022	16	1.19
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	1.29
CD4030	14	.39
CD4034	24	2.49
CD4035	16	1.49

(More in Catalog)

CD4040	16	1.19
CD4041	14	1.19
CD4042	16	.89
CD4043	16	.79
CD4044	16	.79
CD4046	16	1.19
CD4047	14	1.29
CD4048	16	.59
CD4049	16	**.39**
CD4050	16	.39
CD4051	16	.99
CD4052	16	.99
CD4053	16	.99
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	1.49
CD4066	14	.59
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	1.19
CD4078	14	.49
CD4081	14	**.29**
CD4082	14	.29
CD4093	14	.49

CD4098	16	1.95
CD4506	16	1.19
CD4507	14	1.19
CD4508	24	3.95
CD4510	16	1.29
CD4511	16	1.19
CD4512	16	1.19
CD4514	24	2.49
CD4515	24	2.49
CD4516	16	1.19
CD4518	16	1.19
CD4519	16	.59
CD4520	16	1.19
CD4526	16	1.49
CD4528	16	1.49
CD4529	16	1.69
CD4543	16	1.95
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.69
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$2.95
MCS6502	40	MPU w/Clock	5.95
MCS6502B	40	MPU w/Clock at 3MHz	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
6809	40	CPU—8-bit (Internal Clock) 1MHz	14.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N	40	CPU-Sgl. chip 8-bit (128bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	29.95
INS8073N	40	CPU w/Basic Micro Interpreter	29.95
P8085A	40	CPU	4.95
8086	40	CPU 16-bit 5MHz	24.95
8088	40	CPU 8/16-bit	29.95
8155	40	HMOS RAM I/O Port-Timer	6.95
8748	40	HMOS EPROM MPU	24.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$3.95
Z80-CTC	28	Counter Timer Circuit	3.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	10.95
Z80-DMA	40	Direct Memory Access Circuit	9.95
Z80-P10	40	Parallel I/O Interface Controller	3.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	12.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80-S10/9	40	Serial I/O	12.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	4.49
Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
Z80A-DMA	40	Direct Memory Access Circuit	12.95
Z80A-P10	40	Parallel I/O Interface Controller	3.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	12.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	12.95
Z80A-S10/9	40	Serial I/O	12.95
Z80B	40	CPU (MK3880N-6) 6MHz	9.95
Z80B-CTC	28	Counter Timer Circuit	12.95
Z80B-DART	40	Dual Asynch. Receiver/Transmitter	19.95
Z80B-P10	40	Parallel I/O Interface Controller	12.95
Z8001	48	CPU Segmented	44.95
Z8002	40	CPU Non-Segmented	34.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	2.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6809E	40	CPU (1MHz) External (Locking)	14.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	2.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	9.95
MC6850	24	Asynchronous Comm. Adapter	3.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	7.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

INS8080A	40	CPU	2.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95
6843P	40	Floppy Disk Controller (1MHz)	29.95

SPECIAL FUNCTION

DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N-	20	32-seg VAC Fluor. Drvr. (20-pin pkg.)	3.25
IDM2909AJC	28	Microprocessor Sequencer	7.95
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

Part No.	**Pins	DYNAMIC RAMS	Price
1103	18	1024x1 (300ns)	.99
4027	16	**4096x1 (250ns)**	**2.49**
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1 (200ns)	5.95 - 8/44.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	**2048x1 (365ns)**	**.49 - 8/1.95**
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	1.95
2114	18	1024x4 (450ns)	1.49 - 8/9.95
2114L	18	1024x4 (450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4 (200ns)	1.75 - 8/11.95
2114L-2	18	1024x4 (200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	4.95
TMS4045	18	1024x4 (450ns)	3.95
TMS40L47-45	20	1024x4 (450ns)	2.95
5101	22	256x4 (450ns) CMOS	2.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	5.95
HM6116-4	24	2048x8 (200ns) CMOS	4.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8 (150ns) CMOS	39.95
27LS00	16	256x1 (80ns) L.P.	9.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

PROMS / EPROMS

1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	5.95
TMS2532	24	4096x8 (450ns) NMC2532	6.95
TMS2564	28	8192x8 (450ns)	14.95
TMS2716	24	2048x8 (450ns) 3 voltage	9.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	5.95
2716Q-5	24	2048x8 (550ns)	4.49
2732	24	4096x8 (450ns)	6.95
2732A-3	24	4096x8 (300ns)	7.95
2732A-4	24	4096x8 (450ns) 21V	6.95
2732Q-4	24	4096x8 (550ns)	5.95
2758Q-A	24	1024x8 (450ns)	2.95
2764-4	28	8192x8 (450ns)	9.95
2764-3	28	8192x8 (300ns)	14.95
MM5204Q	24	512x8 (1us)	4.95
MCM68764	24	8192x8 (450ns)	24.95
27128	28	16,384x8 (450ns) 128K EPROM	59.95
74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S476	18	1024x4 PROM T.S.	6.95
74S478	24	1024x8 PROM T.S.	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	2.95
82S129	16	256x4 PROM T.S. (27S21)	2.95
82S130	16	512x4 PROM O.C. (27S12)	3.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
82S190	24	2048x8 (80ns)	14.95
82S191	24	2048x8 (80ns)	14.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	14.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	14.95

DATA ACQUISITION

DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	1.49
MC1408L8	18	8-bit D/A Converter (DAC0808LCN)	2.25
ADC0803LCN	20	8-bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-bit A/D Converter (1LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
ADC0817	40	8-bit A/D Converter (16-Ch. Multi.)	9.95
DAC1000	24	10-bit D/A Conv. Micro. Comp. (0.05%)	7.95
DAC1008	20	10-bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1020	16	10-bit D/A Conv. (0.05% Lin.)	7.95
DAC1022	16	10-bit D/A Conv. (0.20% Lin.)	5.95
DAC1222	18	12-bit D/A Conv. (0.20% Lin.)	6.95
LM334Z		Constant Current Source	1.19
LM335Z		Temperature Transducer	1.40
LM399H		Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
AY-5-1013A	**40**	**30K Baud Uart (TR1602)**	**3.95**

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-up
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

SOLDERTAIL (GOLD) STANDARD

	1-9	10-99	100-up
8 pin SG	.30	.27	.25
14 pin SG	.43	.39	.37
16 pin SG	.47	.43	.41
18 pin SG	.53	.49	.47
24 pin SG	.69	.65	.61
28 pin SG	.81	.76	.72
36 pin SG	1.09	1.03	.97
40 pin SG	1.21	1.14	1.08

LP

SG

ST

WW

SOLDERTAIL STANDARD (TIN)

	1-9	10-99	100-up
14 pin ST	.29	.27	.25
16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
20 pin ST	.45	.43	.41
24 pin ST	.49	.46	.43
28 pin ST	.69	.67	.63
40 pin ST	.99	.95	.89

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-9	10-99	100-up
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
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1355 SHOREWAY ROAD, BELMONT, CA 94002

12/83 ***PHONE ORDERS WELCOME — (415) 592-8097 Telex: 176043***

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.
MM54104 Processor Chip .... $14.95 ea.

DT1057 - Expands the DT1050 vocabulary from 137 to over 260 words. Includes 2 ROMs and specs.
Part No. DT1057 .... $24.95 ea.

INTERSIL

*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
FE02030		3½ Digit LCD Display for 7106 & 7116	19.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	16.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

30009 1983 INTERSIL Data Book (1356p.) **$9.95**

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.59
74HC02	14	.59
74HC03	14	.75
74HC04	14	.59
74HCU04	14	.65
74HC08	14	.59
74HC10	14	.59
74HC11	14	.59
74HC14	14	.85
74HC20	14	.59
74HC27	14	.59
74HC32	14	.75
74HC42	16	.99
74HC51	14	.75
74HC58	14	.75
74HC73	14	.79
74HC74	14	.79
74HC75	16	.89
74HC76	16	.79
74HC85	16	1.59
74HC86	14	.69
74HC107	14	.79
74HC109	16	.79
74HC112	16	.79
74HC113	14	.79
74HC132	14	.99
74HC137	16	1.95
74HC138	16	1.09

74HC139	16	.99
74HC147	16	1.19
74HC151	16	.89
74HC153	16	.99
74HC154	24	2.49
74HC157	16	.89
74HC158	16	.89
74HC160	16	1.29
74HC161	16	1.29
74HC162	16	1.29
74HC163	16	1.29
74HC164	14	1.29
74HC165	16	2.79
74HC173	16	1.69
74HC174	16	.99
74HC175	16	.99
74HC192	16	1.39
74HC193	16	1.39
74HC194	16	1.09
74HC195	16	1.09
74HC237	16	2.95
74HC240	20	1.95
74HC241	20	1.95
74HC242	14	1.95
74HC243	14	1.95
74HC244	20	1.95
74HC245	20	2.49

74HC251	16	.89
74HC253	16	.99
74HC257	16	.89
74HC259	16	1.49
74HC266	14	1.19
74HC273	20	2.89
74HC280	14	3.95
74HC373	20	2.39
74HC374	20	2.39
74HC390	16	1.49
74HC393	14	1.49
74HC533	20	2.39
74HC534	20	2.39
74HC595	16	3.95
74HC688	20	3.19
74HC4002	14	.59
74HC4017	16	2.19
74HC4020	16	1.39
74HC4024	14	1.59
74HC4040	16	1.39
74HC4060	16	1.39
74HC4075	14	.59
74HC4078	14	.69
74HC4511	16	2.69
74HC4514	24	3.79
74HC4538	16	2.39
74HC4543	16	3.49

74HCU04 is unbuffered. All others are buffered.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$3.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	3.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	3.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	7.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	7.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	7.95

30012 1982 NATIONAL PAL Data Book (176p.) . . **$5.95**

74C—C/MOS

74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.69
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19

74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	1.19
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39

74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.69
80C97	16	.69

LINEAR

TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35

LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LF347N	14	1.49
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	3.95
TL496CP	8	1.19
NE531V	8	2.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79

LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.89
LM1489N	14	.89
LM1496N	14	1.95
LM1800N	16	2.49
LM1871N	18	2.95
LM1872N	18	3.25
LM1877N-9	14	2.49
LM1889N	18	2.25
LM1896N	14	2.95
LM2002T		1.95
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	2.95
LM3915N	18	2.95
LM3916N	18	2.95
RC4136N	**14**	**1.25**
RC4151NB	8	1.95
RC4194TK		4.49
NE5532	8	2.49
NE5534	8	1.69
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19

MORE AVAILABLE

30003 1982 Nat. Linear Data Book (1952 pgs.) . **$11.95**

Circle 243 on inquiry card.

VOICE SYNTHESIZER FOR APPLE AND COMMODORE

JE520CM

• Over 250 word vocabulary-affixes allow the formation of more than 500 words • Built-in amplifier, speaker, volume control, and audio jack • Recreates a clear, natural male voice • Plug-in user ready with documentation and sample software • Case size: 7¼"L × 3¼"W × 1-3/8"H

APPLICATIONS:

- Security Warning
- Teaching
- Instrumentation
- Telecommunication
- Handicap Aid
- Games

The JE520 VOICE SYNTHESIZER will plug right into your computer and allow you to enhance almost any application. Utilizing National Semiconductor's DIGITALKER™ Speech Processor IC (with four custom memory chips), the JE520 compresses natural speech into digital memory, including the original inflections and emphases. The result is an extremely clear, natural vocalization.

Part No.	Description	Price
JE520CM	For Commodore 64 & VIC-20	$114.95
JE520AP	For Apple II, II+, and *II*e	$149.95

Micro-Logic Corp. MICRO-CHARTS

• Fully decoded data • Instant access • 2-sided, totally comprehensive • Compact 8½x11 in. durable credit card plastic • Perfect for programmers & engineers • Clear & concise tables for: full instruction set, disassembly, ASCII, base conversion, effect of flags, compare vs. jump, interrupt structure, pinout, cycle times, diagrams, bug notes, & much more...

PART NO.	REFERENCE	PRICE
ML-Z80	Z80 CPU	$5.95
ML-8080A	8080A/8085A	$5.95
ML-6502	6502 (65XX)	$5.95
ML-8048	8048, Relatives	$5.95
ML-7400	5400/7400 TTL Pin-Outs	$5.95

BOOKS

30001	**National CMOS Data Book (1981)** (640 pages) 74C, CD4000, and A/D Converters	$6.95
30003	**National Linear Data Book (1982)** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30008	**National Memory Data Book (1980)** (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
30009	**Intersil Data Book (1983)** (1356 pages) Complete line.	$9.95
30010	**National Audio/Radio Handbook (1980)** (240 pages) Pre-Amps, AM, FM & FM Stereo, Power Amps	$5.95
30012	**National PAL Data Book (1982)** (176 pages) Application Notes, Linear Briefs, etc.	$5.95
30013	**Zilog Data Book (1983)** (641 pages) Microprocessors and Support Chips	$7.95
210830	**Intel Memory Components Handbook (1983)** (798 pages) Contains all Application Notes, Article Reprints, Data Sheets, and other design information on Intel's RAMs, EPROMs, E²PROMs & Bubble Memories.	$14.95
210844	**Intel Microprocessor & Peripheral Handbook (1983)** (1027 pages) Contains Data Sheets on all of Intel's Microprocessors and Peripherals.	$14.95

4-Digit Fluorescent Alarm Clock Kit

• Bright 4-digit 0.5" high display • 10 minute snooze alarm
• AM/PM indicator

The JE750 Clock Kit is a versatile 12-hour digital clock with 24-hour alarm. The clock has a bright 0.5" high blue-green flourescent display. The 24-hour alarm allows the user to disable the alarm and immediately re-enable the alarm to activate 24 hours later. The kits includes all documentation, components, case and wall transformer. Size: 6-5/8"L × 3¼"H × 1¾"D.

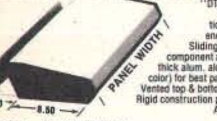
JE750 Alarm Clock Kit $29.95

Jameco ELECTRONICS Digital Thermometer Kit

Dual sensors — switch controls for indoor/outdoor or dual monitoring — can be extended to 500 feet. Continuous LED .8" ht. display. Range: -40°F to 199°F, -40°C to 100°C. Accuracy ±1° nominal. Calibrate for Fahrenheit/Celsius. Simulated walnut case. AC wall adapter included. Size: 6⅝"L x 3⅞"H x 1⅞"D.

JE300...... $39.95

Universal Computer Keyboard Enclosures



"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

DTE-8	Panel Width 7.5"	$24.95
DTE-11	Panel Width 10.13"	$27.95
DTE-14	Panel Width 13.5"	$29.95
DTE-20	Panel Width 19.25"	$34.95
DTE-22	Panel Width 21.375"	$39.95

Circle 243 on inquiry card.

CARD-EDGE CONNECTOR
Mates with double-sided 1/16" PC board with contact fingers on .100" centers

CARD-EDGE CONNECTORS

Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
C20	20	2.39	2.09	1.89
C26	26	2.69	2.39	2.09
C34	34	3.29	2.95	2.59
C40	40	3.69	3.29	2.89
C50	50	4.39	3.95	3.39

SOLDER TRANSITION CONNECTORS

FOR PERMANENT TERMINATION TO PRINTED CIRCUIT BOARDS

Part No.	No. of Contacts	1-9	10-99	100+
ST20	20	1.15	.99	.89
ST26	26	1.25	1.15	.99
ST34	34	1.49	1.35	1.15
ST40	40	1.69	1.55	1.35
ST50	50	1.89	1.69	1.49

36-Pin CENTRONICS RIBBON CONNECTORS 24-Pin IEEE488

Part No.	No. of Contacts/ Style	1-9	10-99	100+
CEN14M	14 Male	6.39	5.49	4.49
CEN14F	14 Female	6.19	5.29	4.29
CEN24M	24 Male	7.95	6.95	5.95
CEN24F	24 Female	7.69	6.79	5.75
CEN36M	36 Male	8.69	7.59	6.49
CEN36F	36 Female	9.75	8.95	7.95

SOCKET CONNECTOR
Mates with 2 rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles

SOCKET CONNECTORS

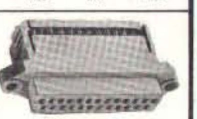
Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
S20	20	1.39	1.25	1.09
S26	26	1.69	1.49	1.35
S34	34	2.09	1.79	1.59
S40	40	2.29	2.09	1.79
S50	50	2.69	2.39	2.09
S60	60	3.39	2.95	2.59

MALE CONNECTOR

Mates with Socket Connector .10" x .10"

Part No.	No. of Contacts/ Conductors	1-9	10-99	100+
M20	20	4.09	3.65	3.19
M26	26	4.49	3.95	3.49
M34	34	4.95	4.49	3.95
M40	40	5.49	4.89	4.29
M50	50	6.49	5.75	4.95

D-SUB CONNECTORS



Part No.	No. of Contacts/ Style	1-9	10-99	100+
CDE9P	9 Male	2.95	2.65	2.29
CDE9S	9 Female	3.39	3.09	2.69
CDA15P	15 Male	3.95	3.55	3.09
CDA15S	15 Female	4.75	4.19	3.69
CDB25P	25 Male	5.49	4.79	4.25
CDB25S	25 Female	5.95	5.49	4.85
CDC37P	37 Male	7.79	6.95	6.09
CDC37S	37 Female	8.95	7.95	6.95

28AWG FLAT GREY CABLE

Part No.	No. of Contacts/ Conductors	Connector & Wire Type	Price Per Foot
171-9	9	28AWG Flat Stranded	.19
171-14	14	28AWG Flat Stranded	.25
171-15	15	28AWG Flat Stranded	.27
171-16	16	28AWG Flat Stranded	.29
171-20	20	28AWG Flat Stranded	.36
171-24	24	28AWG Flat Stranded	.45
171-25	25	28AWG Flat Stranded	.47
171-26	26	28AWG Flat Stranded	.49
171-34	34	28AWG Flat Stranded	.62
171-36	36	28AWG Flat Stranded	.65
171-37	37	28AWG Flat Stranded	.69
171-40	40	28AWG Flat Stranded	.75
171-50	50	28AWG Flat Stranded	.89

CUSTOM ASSEMBLIES

Use the part numbers from the connectors and cable to order your own custom assembled cables.

EXAMPLE: If you desire a 25-foot cable with a male "Centronics" connector on one end, and a female "Centronics" connector on the other end, you would order:

CEN36M-25' -CEN36F CUSTOM

$8.69 (CEN36M) + 9.75 (CEN36F) =	$18.44
.65 × 25 (25 feet 36 cond. cable) =	$16.25
2.00 Set-up charge on all custom cables =	$ 2.00
This (CEN36M-25' -CEN36F CUSTOM) Cable would cost	$36.69

Please specify "CUSTOM" after the part no. to ensure your order will be filled correctly. (**Important:** Please specify cable in FEET, not inches)

ALL CUSTOM ASSEMBLIES MUST BE PREPAID BEFORE ASSEMBLY. THERE ARE NO RETURNS ON CUSTOM CABLE ASSEMBLIES. $7.00 SET-UP CHARGE (PER STYLE) ON ALL CUSTOM CABLES.

ACCESSORIES FOR APPLE* COMPUTERS

Numeric/Auxiliary Keypad for APPLE *II*e*

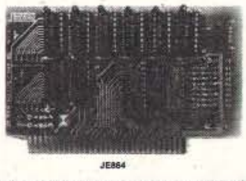
Computer-Ready

JE614

The JE614 is a newly introduced numeric/auxiliary keypad for the APPLE *II*e.* It offers the flexibility of a 10-key pad and the convenience of 23 directly accessible functions. Screen manipulating functions make word processing a snap and cursor controls make the keypad ideal for VisiCalc** users. The JE614 Keypad is housed in a durable metal enclosure and is color-coordinated with your APPLE *II*e computer. Operation of the keypad can begin within minutes from unpacking. Special functions include: Home, Clear, Clear to End of Screen, Scroll-Up, Scroll-Down, Tab, Delete, Left, Right, Up and Down. Each key has auto-repeat.

JE614 Assembled and Tested $89.95

Extended 80 Column/64K RAM Card for APPLE *II*e*



JE864

Now you can double the memory capacity and get an 80 column display format for your APPLE *II*e computer at an affordable price. Just plug the JE864 card into your APPLE and expand your display to 80-characters per line. Perfect for word processing. The JE864 also features 64K bytes of additional memory to allow programming not possible with standard APPLE *II*e computers.

Board: High density board design squeezes 64K bytes of RAM onto a 2½" × 4½" board • Fully tested to assure proper operation.

Uses: Word processing — displays 1000 more characters per screen • Extra memory allows running of extremely large programs • Ultra High Resolution Graphics (when software available).

JE864 Assembled and Tested $149.95

Switching Power Supply for APPLE II, II+ and *II*e*

• Can drive four floppy disk drives and up to eight expansion cards • Short-circuit and overload protection • Fits inside Apple computer • Fully regulated +5V @ 5A, +12V @ 3A, -5V @ .5A, -12V @ .5A • Apple-type plug in power cord included • Size: 9⅞"L × 3⅞"W × 2⅞"H • Weight: 2 lbs.

Part No. KHP4007 .... $79.95

Cooling Fan for APPLE II, II+ and *II*e*

• Snaps on the side of APPLE II, II+ and *II*e* enclosures • Eliminates overheating problems, thereby boosting reliability and operation life of computer • Switch on front of fan serves as power switch for fan, computer, and provided extra outlet

Part No. APF-1 .... $49.95

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POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING

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JE664 EPROM PROGRAMMER
8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, < 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers. The JE665 can be interfaced to any computer with an RS232 port. Information is also provided for interfacing to any CP/M system with an RS232 port.

JE664-ARS EPROM Programmer w/JE665 Option $1195.00
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EPROM JUMPER MODULES - The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

P/N	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI (25V)	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI, (25V)	$14.95
JM16B	TMS2716	Motorola, TI (+5, -5, +12)	$14.95
JM32A	TMS2532	Motorola, TI (25V)	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel (25V)	$14.95
JM32C	2732A (21V)	Fujitsu, Intel (21V)	$14.95
JM64A	MCM68764, MCM68L764	Motorola (21V)	$14.95
JM64B	2764	Intel (21V)	$14.95
JM64C	TMS2564	TI (25V)	$14.95
JM64D	HN482764G-4	Hitachi (21V)	$14.95

UV-EPROM Eraser

8 Chips — 51 Minutes

1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

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• Uses Shugart SA390 mechanics • 143K formatted storage • 35 tracks — compatible with Apple controller • Complete with connector and cable — just plug into your disk controller card • Size: 6"L × 3½"W × 8-9/16"D • Weight: 4¼ lbs.

Part No. ADD-514 $195.95

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- 400/800K Bytes Capacity
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Part No.	Price
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2114-25	1024 x 4 (250ns)	8/9.95
2114L-4	1024 x 4 (450ns) (LP)	8/11.95
2114L-3	1024 x 4 (300ns) (LP)	8/12.45
2114L-2	1024 x 4 (200ns) (LP)	8/12.95
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TMS4044-4	4096 x 1 (450ns)	3.45
TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
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TMM2016-150	2048 x 8 (150ns)	4.90
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HM6116-3	2048 x 8 (150ns) (cmos)	4.90
HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
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LP = Low Power   Qstat = Quasi-Static

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4116-200	16384 x 1(200ns)	8/11.95
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4116-120	16384 x 1(120ns)	8/28.95
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4164-200	65536 x 1(200ns) (5v)	5.90
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5V = single 5 volt supply

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TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.90
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.90
2732-250	4096 x 8 (250ns) (5v)	8.90
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5v = Single 5 Volt Supply

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74LS00	.23	74LS173	.68
74LS01	.24	74LS174	.54
74LS02	.24	74LS175	.54
74LS03	.24	74LS181	2.10
74LS04	.23	74LS189	8.90
74LS05	.24	74LS190	.88
74LS08	.27	74LS191	.88
74LS09	.28	74LS192	.78
74LS10	.24	74LS193	.78
74LS11	.34	74LS194	.68
74LS12	.34	74LS195	.68
74LS13	.44	74LS196	.78
74LS14	.58	74LS197	.78
74LS15	.34	74LS221	.88
74LS20	.24	74LS240	.94
74LS21	.28	74LS241	.98
74LS22	.24	74LS242	.98
74LS26	.28	74LS243	.98
74LS27	.28	74LS244	1.25
74LS28	.34	74LS245	1.45
74LS30	.24	74LS247	.74
74LS32	.28	74LS248	.98
74LS33	.54	74LS249	.98
74LS37	.34	74LS251	.58
74LS38	.34	74LS253	.58
74LS40	.24	74LS257	.58
74LS42	.48	74LS258	.58
74LS47	.74	74LS259	2.70
74LS48	.74	74LS260	.58
74LS49	.74	74LS266	.54
74LS51	.24	74LS273	1.45
74LS54	.28	74LS275	3.30
74LS55	.28	74LS279	.48
74LS63	1.20	74LS280	1.95
74LS73	.38	74LS283	.68
74LS74	.34	74LS290	.88
74LS75	.38	74LS293	.88
74LS76	.38	74LS295	.98
74LS78	.48	74LS298	.88
74LS83	.59	74LS299	1.70
74LS85	.68	74LS323	3.45
74LS86	.38	74LS324	1.70
74LS90	.54	74LS352	1.25
74LS91	.88	74LS353	1.25

74LS92	.54	74LS363	1.30
74LS93	.54	74LS364	1.90
74LS95	.74	74LS365	.48
74LS96	.88	74LS366	.48
74LS107	.38	74LS367	.44
74LS109	.38	74LS368	.44
74LS112	.38	74LS373	1.35
74LS113	.38	74LS374	1.35
74LS114	.38	74LS377	1.35
74LS122	.44	74LS378	1.13
74LS123	.78	74LS379	1.30
74LS124	2.85	74LS385	1.85
74LS125	.48	74LS386	.44
74LS126	.48	74LS390	1.15
74LS132	.58	74LS393	1.15
74LS133	.58	74LS395	1.15
74LS136	.38	74LS399	1.45
74LS137	.98	74LS424	2.90
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74LS145	1.15	74LS624	3.95
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74LS153	.54	74LS669	1.85
74LS154	1.85	74LS670	1.45
74LS155	.68	74LS674	9.60
74LS156	.68	74LS682	3.15
74LS157	.64	74LS683	3.15
74LS158	.58	74LS684	3.15
74LS160	.68	74LS685	3.15
74LS161	.64	74LS688	2.35
74LS162	.68	74LS689	3.15
74LS163	.64	74LS783	23.95
74LS164	.68	81LS95	1.45
74LS165	.94	81LS96	1.45
74LS166	1.90	81LS97	1.45
74LS168	1.70	81LS98	1.45
74LS169	1.70	25LS2521	2.75
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6500

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6505	8.90
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6522	7.90
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2 MHZ

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3 MHZ

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8237-5	20.95
8238	4.45
8243	4.40
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8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
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Z80A-DMA	15.95
Z80A-PIO	4.90
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Z80A-SIO/1	15.95
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Z80B-CPU	12.95
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78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
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C,T = TO-220 K = TO-3 L = TO-92

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	1-99	100
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14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call
ST = SOLDERTAIL		
8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75
WW = WIREWRAP		
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3.579535	3.90
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5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
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18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

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Circle 157 on inquiry card.

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To: Byte Readers

All of us at Computer Components Unlimited would like to take the time to say "thanks" for your continuing support of our company throughout the past year. We have some very exciting things happening in the next few months. Watch for us in the upcoming issues of Byte Magazine.

Have a safe and Happy Holiday.

Thank you,

Kirk E. Frantz
Kirk E. Frantz
President, Computer Components Unlimited

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P/N Q64, 64K w/4 functions	395	279
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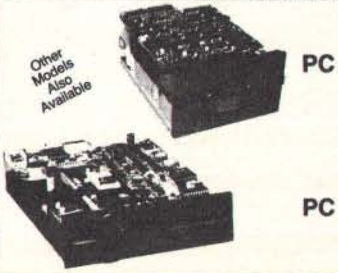

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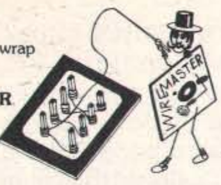

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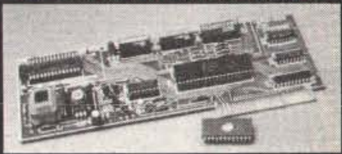

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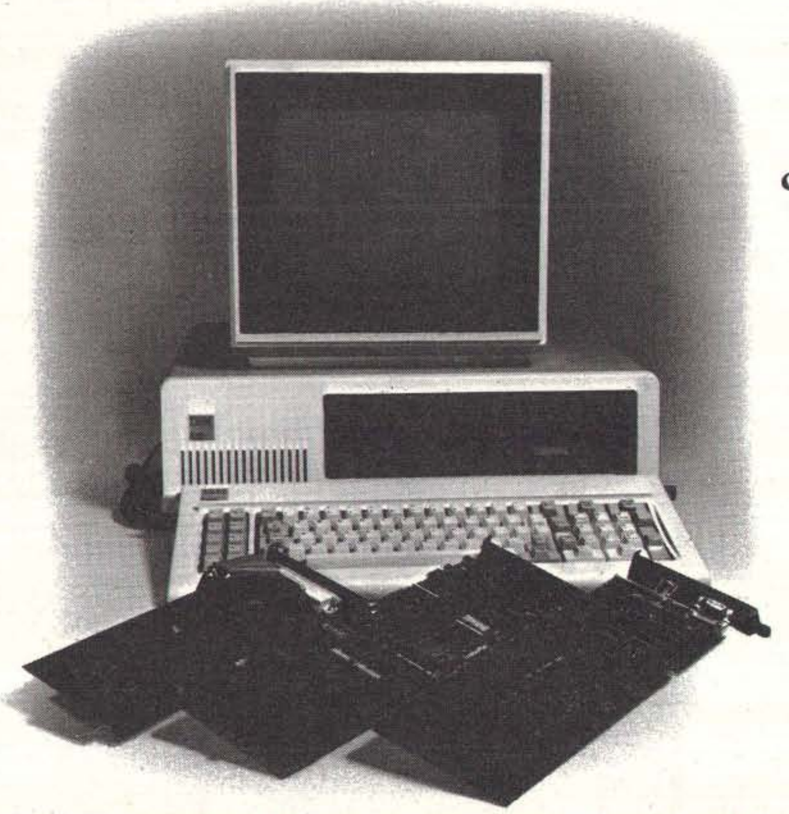

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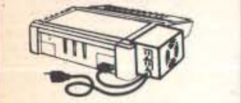

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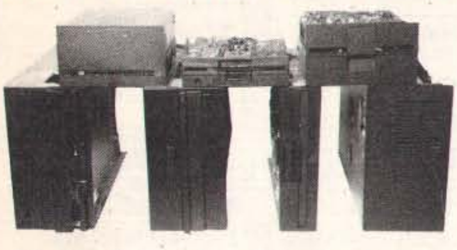

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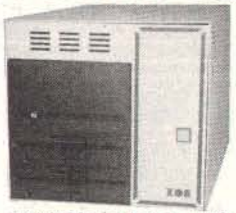

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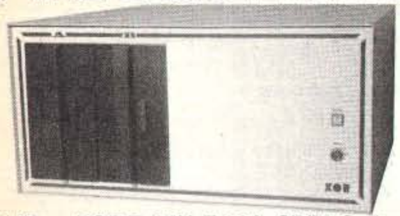
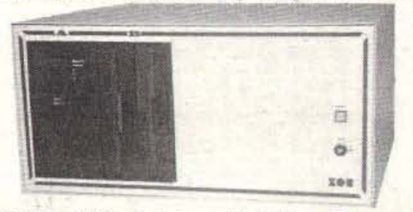


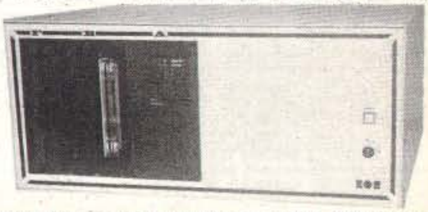
2.4 Meg DS/DD 64K Z-80A CP/M System

This "Industry Standard" computer features a 12 slot motherboard, 30 amp power supply, 2 serial RS-232 ports, centronics parallel port and CP/M software. The XOR disk controller included, will read and write the I.B.M. 3740 format (8" CP/M standard) as well as R/W single on double sided, single or double density, and any byte/size sector. One year parts and labor on the complete system. #S-1000-36 .... **$2345.00**



20 Meg Winchester w/2.4 Meg Floppys

For the serious professional this system features the famous S-100-12 cabinet with XOR's S1-MOD 12-slot motherboard. The Quantum hard disk has two 10 Meg platters (A: and B:). One platter can be "backed-up" on another. 2/DS/DD 1.2 floppys are used for software entry, copies, and back-up. One year parts and labor. #S-1000-63 ...... **$5275.00**



20M H.D. with 17M Tape and 1.2M Floppy

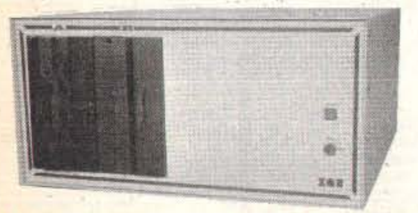
Backup your priceless data on this full 17 megabyte tape drive and be able to pip files between any of the three peripherals for total versatility. Boot CP/M from hard disk or floppy, change tapes for archival storage. Reads and writes the IBM 3740 Format (8" CPM standard).

#S-1000-69	**$6390.00.**
Above system 40 megabyte hard disk #S-1000-82	**$7240.00**

A word on Special Orders and Configuring the System you need:

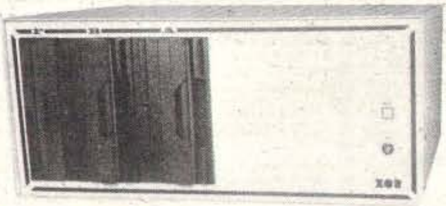
We've built and shipped hundreds of **Custom Computers** that we have never advertised but, have been able to build to the customer specifications. Examples: A 10 port hard disk system set-up to poll micro-wave devices; a Micro Manager interfaced to an X-Ray machine; a 7-User system with six of the users at satellite stations via phone line modem communication throughout the United States. So whatever configuration you need; 4 floppies, 4 hard disks, 10 serial ports, etc., call us **Toll Free** and talk to our Engineering Sales Crew and let us quote a price and delivery date that will satisfy your needs.

★ THE OFFICE MASTERS! REMOVABLE CARTRIDGE DISK SYSTEMS ★



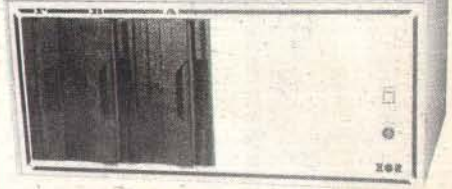
10 Meg Cartridge Disk And 1.2 Meg Floppy

An office system at an almost unbelievable price when you consider the bundle of applications software that comes with the system. Ten megabytes of formatted storage on a removable cartridge disk allows unlimited storage space with extra 10 Meg cartridges available at $50.00 each. With the speed and reliability of a hard disk and removability of a floppy this office master is the choice. #S-1000-74 .... **$3695.00**



TWO 10 Meg Removable and DS/DD Floppy

Destined to be our #1 seller and no one else makes anything like it. A true state-of-the-art system with virtually no-limit to storage capacities in 10 Meg removable cartridges. Backup problems? Get high speed backup from cartridge to cartridge, ten megabytes worth, in 6 minutes! HINT: We don't use "PIP." Future technology here today. #S-100-76 ...... **$4595.00**



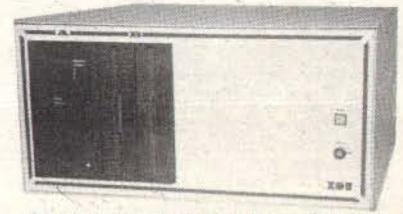
4 User Cartridge Disk System

Four users and two 10 megabyte removable cartridge disks may be just what you want to automate your office or small business, with all the software packages you'll ever need. A multi-user version of the system at left, these users can be up to 100 feet away from each other. Most any terminal will work with the user ports. #S-1000-80 ...... **$5825.00**

★ THE BUSINESS PROFESSIONALS: HARD DISK MULTI-USER SYSTEMS ★

2 User Hard Disk System

A twenty meg hard disk (2 platter) with a DS/DD 1.2 Meg floppy disk makes this a perfect system for a small business. Two user allows dual access to the system files with each station up to 100 feet apart! Includes above software. Full one year parts and labor. #S-1000-61 .... **$5495.00**



40 Meg Hard Disk 4 User System

A must for a growing business! Two DS/DD floppys (2.4 Meg) for data backup and copy with a 4 platter 40 Meg hard disk four user capability to automate the whole front office. You can even designate a 10 Meg platter to each user! Same warranty as all our products — (configurable from 2 to 7 users) #S-1000-60 **$7295**

7 User 85 Meg w/17 Meg Backup

Now it's available, the automated business system to run even those large companies! 7 separate users tied into one professional host system. If 85 Meg isn't enough, we can put together as much as three hundred and forty megabytes! Full 17 Meg tape backup insures archival storage of valuable data #S-1000-98 **$9595.00**

4164 64K DYNAMIC 200 NS $595 TMM2016 2KX8 STATIC 200 NS $415

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.49
2111	256 x 4 (450ns)	2.49
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114-25	1024 x 4 (250ns)	8/10.95
2114L-4	1024 x 4 (450ns) (LP)	8/12.95
2114L-3	1024 x 4 (300ns) (LP)	8/13.45
2114L-2	1024 x 4 (200ns) (LP)	8/13.95
TC5514	1024 x 4 (650ns) (cmos)	2.49
TC5516	2048 x 8 (250ns) (cmos)	9.95
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TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
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HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95
HM6264	8192 x 8 (150ns) (cmos)	49.95

LP = Low Power   Qstat = Quasi-Static

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MK4108	8192 x 1	(200ns)	1.95
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4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/11.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

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2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
2732A-4	4096 x 8 (450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8 (250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8 (200ns) (5v) (21vPGM)	13.95
2764	8192 x 8 (450ns) (5v)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v) (24 pin)	39.95
27128	16384x8 (300ns) (5v)	29.95

5v = Single 5 Volt Supply   21vPGM = Program at 21 Volts

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

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6.0	3.95
6.144	3.95
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74LS01	.25	74LS174	
74LS02	.25	74LS175	
74LS03	.25	74LS181	2
74LS04	.24	74LS189	8
74LS05	.25	74LS190	
74LS08	.28	74LS191	
74LS09	.29	74LS192	
74LS10	.25	74LS193	
74LS11	.35	74LS194	
74LS12	.35	74LS195	
74LS13	.45	74LS196	
74LS14	.59	74LS197	
74LS15	.35	74LS221	
74LS20	.25	74LS240	
74LS21	.29	74LS241	
74LS22	.25	74LS242	
74LS26	.29	74LS243	
74LS27	.29	74LS244	1
74LS28	.35	74LS245	1
74LS30	.25	74LS247	
74LS32	.29	74LS248	
74LS33	.55	74LS249	
74LS37	.35	74LS251	
74LS38	.35	74LS253	
74LS40	.25	74LS257	
74LS42	.49	74LS258	
74LS47	.75	74LS259	2
74LS48	.75	74LS260	
74LS49	.75	74LS266	
74LS51	.25	74LS273	1
74LS54	.29	74LS275	3
74LS55	.29	74LS279	
74LS63	1.25	74LS280	1.
74LS73	.39	74LS283	
74LS74	.35	74LS290	.
74LS75	.39	74LS293	.
74LS76	.39	74LS295	.
74LS78	.49	74LS298	.
74LS83	.60	74LS299	1.
74LS85	.69	74LS323	3.
74LS86	.39	74LS324	1.
74LS90	.55	74LS352	1.
74LS91	.89	74LS353	1.
74LS92	.55	74LS363	1.
74LS93	.55	74LS364	1.
74LS95	.75	74LS365	.
74LS96	.89	74LS366	.
74LS107	.39	74LS367	.
74LS109	.39	74LS368	.
74LS112	.39	74LS373	1.
74LS113	.39	74LS374	1.
74LS114	.39	74LS375	.
74LS122	.45	74LS377	1.
74LS123	.79	74LS378	1.
74LS124	2.90	74LS379	1.
74LS125	.49	74LS385	3.
74LS126	.49	74LS386	.
74LS132	.59	74LS390	1.
74LS133	.59	74LS393	1.
74LS136	.39	74LS395	1.
74LS137	.99	74LS399	1.
74LS138	.55	74LS424	2.
74LS139	.55	74LS447	.
74LS145	1.20	74LS490	1.
74LS147	2.49	74LS624	3.
74LS148	1.35	74LS640	2.
74LS151	.55	74LS645	2.
74LS153	.55	74LS668	1.
74LS154	1.90	74LS669	1.
74LS155	.69	74LS670	1.4
74LS156	.69	74LS674	14.
74LS157	.65	74LS682	3.2
74LS158	.59	74LS683	3.2
74LS160	.69	74LS684	3.2
74LS161	.65	74LS685	3.2
74LS162	.69	74LS688	2.4
74LS163	.65	74LS689	3.2
74LS164	.69	81LS95	1.4
74LS165	.95	81LS96	1.4
74LS166	1.95	81LS97	1.4
74LS168	1.75	81LS98	1.4
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4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
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14409	12.95	74C902	.85
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14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
4502	.95	74C908	2.00
4503	.65	74C909	2.75
4508	1.95	74C910	9.95
4510	.85	74C911	8.95
4511	.85	74C912	8.95
4512	.85	74C914	1.95
4514	1.25	74C915	1.19
4515	1.79	74C918	2.75
4516	1.55	74C920	17.95
4518	.89	74C921	15.95
4519	.39	74C922	4.49
4520	.79	74C923	4.95
4522	1.25	74C925	5.95
4526	1.25	74C926	7.95
4527	1.95	74C928	7.95
		74C929	19.95

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

DATA ACQUISITION

ADC0800	15.55
ADC0804	3.49
ADC0809	4.49
ADC0817	9.95
DAC0800	4.95
DAC0808	2.95
DAC1020	8.25
DAC1022	5.95
MC1408L6	1.95
MC1408L8	2.95

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

9000 SERIES

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1558H	3.10
LM301H	.79	LM348	.99	LM567	.89	LM1800	2.37
LM307	.45	LM350K	4.95	NE570	3.95	LM1812	8.25
LM308	.69	LM350T	4.60	NE571	2.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE590	2.50	LM1871	5.49
LM309H	1.95	LM359	1.79	NE592	2.75	LM1872	5.49
LM309K	1.25	LM376	3.75	LM709	.59	LM1877	3.25
LM310	1.75	LM377	1.95	LM710	.75	LM1889	1.95
LM311	.64	LM378	2.50	LM711	.79	LM1896	1.75
LM311H	.89	LM380	.89	LM723	.49	ULN2003	2.49
LM312H	1.75	LM380N-8	1.10	LM723H	.55	LM2877	2.05
LM317K	3.95	LM381	1.60	LM733	.98	LM2878	2.25
LM317T	1.19	LM382	1.60	LM741	.35	LM2900	.85
LM318	1.49	LM383	1.95	LM741N-14	.35	LM2901	1.00
LM318H	1.59	LM384	1.95	LM741H	.40	LM3900	.59
LM319H	1.90	LM386	.89	LM747	.69	LM3905	1.25
LM319	1.25	LM387	1.40	LM748	.59	LM3909	.98
LM320 (see 7900)		LM389	1.35	LM1014	1.19	LM3911	2.25
LM322	1.65	LM390	1.95	LM1303	1.95	LM3914	3.95
LM323K	4.95	LM392	.69	LM1310	1.49	LM3915	3.95
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LM331	3.95	LM399H	5.00	MC1350	1.19	MC4044	4.50
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LM337T	1.95	NE561	24.95	LM1488	.69	RC4558	.69
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H = TO-5 CAN T = TO-220 K = TO-3

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220 K = TO-3
L = TO-92

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ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

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XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	2.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

74S00

74S00	.32
74S02	.35
74S03	.35
74S04	.35
74S05	.35
74S08	.35
74S09	.40
74S10	.35
74S11	.35
74S15	.35
74S20	.35
74S22	.35
74S30	.35
74S32	.40
74S37	.88
74S38	.85
74S40	.35
74S51	.35
74S64	.40
74S65	.40
74S74	.50
74S85	1.99
74S86	.50
74S112	.50
74S113	.50
74S114	.55
74S124	2.75
74S132	1.24
74S133	.45
74S134	.50
74S135	.89
74S138	.85
74S139	.85
74S140	.55
74S151	.95
74S153	.95
74S157	.95
74S158	.95
74S161	1.95
74S162	1.95
74S163	1.95
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.22uf						.40	
.27						.40	
.33						.40	.45
.47				.35			.50
.68						.45	.50
1.0			.40	.40	.45	.45	
1.5				.45		.50	.60
1.8							.75
2.2		.35	.40	.45		.65	.85
2.7		.40	.45				.90
3.3		.45	.50	.55	.60	.65	.90
3.9		.45					
4.7	.45	.55		.60	.65	.85	.90
6.8			.70		.75		
8.2							1.00
10	.55	.65	.80	.85	.90	1.00	
12	.65		.85	.90			
15	.75	.85	.90				
18			1.25				
22		1.00	1.35				
27			2.25				
39		1.50					
47	1.35						
56	1.75						
100		3.25					
270	3.75						

DISC

10pf	50V	.05	470	50V
22	50V	.05	560	50V
25	50V	.05	680	50V
27	50V	.05	820	50V
33	50V	.05	.001uf	50V
47	50V	.05	.0015	50V
56	50V	.05	.0022	50V
68	50V	.05	.005	50V
82	50V	.05	.01	50V
100	50V	.05	.02	50V
220	50V	.05	.05	50V
330	50V	.05	.1	12V
			.1	50V

MONOLITHIC

.1uf-mono 50V .18   .47uf-mono 50V

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.1
1	25V	.14	4.7	16V	.1
2.2	35V	.15	10	16V	.1
4.7	50V	.15	10	50V	.1
10	50V	.15	22	16V	.1
47	35V	.18	47	50V	.2
100	16V	.18	100	15V	.2
220	35V	.20	100	35V	.2
470	25V	.30	150	25V	.2
2200	16V	.60	220	25V	.3
			330	16V	.4
			500	16V	.4
			1000	16V	.6
			1500	16V	.7
			6000	16V	.8

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4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
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MCT-6	1.50	TIL-113	1.75

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1N759	12.0 volt zener	.25
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KBP04	400PIV 1.5amp bridge	.55
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2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

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	1-99	100
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14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
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40 pin WW	1.99	1.80
WW = WIREWRAP		
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ZIF = TEXTOOL (Zero Insertion Force)		

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7 POSITION	.95
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VISA

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Jumbo Green	.18	.1
Jumbo Yellow	.18	.1

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.1 UF DISC	100/8.0
.1 UF MONOLITHIC	100/15.0

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MAN 74	.3"	CC	.99
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MPI

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- ★ FITS STANDARD 5¼" DRIVES, INCL. SHUGART
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20	1.89	1.25	
22	1.89	1.25	
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40	2.99	2.10	4.15

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CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP		RIGHT ANGLE PC SOLDER		IDC RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DB**xx**P	DB**xx**S	DB**xx**PR	DB**xx**SR	IDB**xx**P	IDB**xx**S	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

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IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDH**xx**S	IDH**xx**SR	IDH**xx**W	IDH**xx**WR	IDS**xx**	IDM**xx**	IDE**xx**
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

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Unclassified Ads

NEEDED: Nonprofit performing-arts foundation seeks tax-deductible donations of portable computer with or without printer, typewriters, and TI-compatible printer to aid us in mailings, finances, and fund raising. Hugh Appet, American Dance Foundation Inc., 2291 Broadway, New York, NY 10024, (212) 799-5445.

WANTED: Nonprofit group of volunteer professionals devoted to rehabilitation research and community service for persons with hearing or vision impairments needs TI 99/4A, cassette, RS-232C interface and modem, VIC-20s with datasettes, VICModem, two green monitors, and IEEE-488- or RS-232C-compatible dot-matrix printer. Will pay shipping. Donations are fully tax exempt. J. Whitlock, New England Institute of Applied Biophysics, 59 North Ashland St., Worcester, MA 01609, (617) 798-8707.

WANTED: Elwyn Institute is a nonprofit rehabilitation center seeking a distributor for new ribbon cartridges that are assembled, tested, and manufactured by handicapped people. We also welcome tax-exempt donations of word-processing equipment. Alvin Sydnor, Elwyn Institute, 5001 Lancaster Ave., Philadelphia, PA 19131, (215) 477-9100.

WANTED: A donation of any micro- or minicomputer for an educational cause. Will accept computer books, computer audio/visual materials, video player/recorder plus compatible color TV. Also, will buy: Apple II or IIe and Europlus 48K microcomputer with drives, controllers (with or without), a 12-inch green screen, a 16K RAM card, Z80 CP/M card, 80-column matrix printer, and more. Tendekai Muzorewa, POB FM156, Famona, Bulawayo, Zimbabwe, Africa, tel: 34916 Bulawayo.

WANTED: Student (micro)electronic class needs your discarded or unwanted computers, systems, printers, or parts for educational use. Jim Seals, 1819 North Semoran Blvd., Orlando, FL 32807.

WANTED: Two nonprofit organizations, a church-youth group and school FTA, need a new or slightly used TI 99/4A-compatible printer with cords. Donations are tax deductible. Brian Neidig, 2105 Old Coupland Rd., Taylor, TX 76574.

WANTED: Christian church seeks donation of personal computer for church-accounting purposes. Gifts are tax deductible. Rev. Feeser or Nate Solem, Grace Lutheran Church, 2101 Harrison St., Kingman, AZ 86401, (602) 753-3068.

WANTED: The Solebury Student Computer Club is interested in trading Apple-compatible software. Please send your list of software. The Solebury Student Computer Club, Phillips Mill Rd., New Hope, PA 18938.

WANTED: College student needs programs of a scientific or mathematical nature for the Apple II, II Plus, and IIe, especially in chemistry and physics. If you send a disk, I will return it with utility programs. Eli Rotenberg, 1203 Magee Ave., Philadelphia, PA 19111.

WANTED: High school student would appreciate a donated computer for programming and experimentation purposes. Karl Smolenski, 2924 R. 54a, Penn Yan, NY 14527.

WANTED: High school student needs computer or spare parts to make one. Also, any computer books. Norm Guertin, 281 Grafton St., Worcester, MA 01604.

FOR SALE: Back issues of BYTE from January 1980 to December 1982, except January 1982. Good condition: all for $100, postage paid anywhere in the continental US. Send cashier's check or money order. Phil Busch, 790 Northeast Wharton Dr., Grants Pass, OR 97526, (503) 474-1354.

FOR TRADE: Entire sheet of POKEs and PEEKs along with collection of programs for exchange with TRS-80 Color Computer users. Send list of all programs to swap with mine, also any information that may be passed on. Stephen Inoue, 4194 Tambor Rd., San Diego, CA 92124, (619) 571-1412.

WANTED: One copy of BYTE Vol. 1, No. 5, January 1976, to make set complete. W.A. Winshall, 3 Ferndale Rd., Weston, MA 02193, (617) 235-5360.

FOR SALE: North Star Horizon, 5 users, 352K RAM, 5¼-inch disk drive, 338K, ten I/O serial ports, Z80A CPU, 14-inch hard disk 18 MB, HDOS, CP/M, TSS/C, HBASIC. Cost over $12,000, sell $5750 or near offer. The Armchair Sailor Bookstore, Lee's Wharf, Newport, RI 02840, (401) 847-4252.

FOR SALE: Winchester Tallgrass double-disk drive, 12 plus 12 megabyte tape backup, almost new, considerably below market price. Also, Cyma Dental Receivable program to sell or trade for new Softward. Judith D. Sutterfield, 1800 Alamo Ave., Colorado Springs, CO 80907.

FOR SALE: Modified TRS-80 Model I Level II, 16K computer. Includes cassette, stringy floppy, wafers with programs for both business and games; TRS-80 Line Printer; and custom-built table. Entire system to go, worth over $1100, asking $800. Joel Minchinton, 107 South 2nd St., Wahpeton, ND 58075, (701) 642-1326.

WANTED: High school student would like donated Apple computer equipment, cards, peripherals, anything unwanted. I will gladly pay all postage. Chris Faigle, 3001 River Hills Terrace, Midlothian, VA 23113, (804) 794-8903.

FOR SALE: Seven Compupro 16K static memory boards; four Compupro 8K static memory boards; two MITS 4K static memory boards; two MITS ROM BASIC; two MITS floppy-disk controllers; 2 MITS 8080 CPU boards; one MITS turnkey module; and two MITS cassette adapters. Also, Western Digital WD1000-85: $375 and SOROC IQ 120, CRT, good condition: $350. David E. Boston, POB 518, Cedarville, OH 45314, (513) 766-5198.

FOR SALE: Micro Term ACT-IVa: $275. Sanyo 15-inch black-and-white video monitor: $150. Zenith Z-19A terminal: $470. Sinclair ZX81: $28. DEC MSVII-DD (64K-byte Q-bus dual-height RAM board): $250. DEC DLVIIJ (Q-bus 4-serial line board) with cables: $320. Vadic 3400 modem, 1200 bits per second, full duplex: $395. All perfect. R. Thornton, (516) 686-7890 or 626-3919.

FOR SALE: Apple II Plus 48K, keyboard replaced. Hefty power supply: $900 or offer. Without power supply and case: $625. Mark Carroll, 1550 Beverly Place, Berkeley, CA 94706, (415) 525-7608 or 658-6719.

FOR SALE: Four new Apple II- and IIe-compatible disk drives that include half-tracking, CP/M, Pascal, DOS 3.3 and 3.2: $225 each or $880 for all. Also, Atari cartridges: Indy 500 ($25) and Speedway II ($9). Peter Doty, 4813 Northwest 19th Place, Gainesville, FL 32605, (904) 376-0542.

FOR SALE: North Star Horizon 32K with two QD disk drives, Wordsmith word-processing system (40-line by 85-column screen), detached WP keyboard, and software: $2150. Also, Diablo 1650 printer: $2000. All in perfect condition. Bob Renegar, 23 Brookside Rd., Wallingford, PA 19086, (215) 566-4097.

FOR SALE: Motorola 6800 system with SOROC 1Q-120 terminal, SwTPC motherboard, MP-AZ processor board, two 8K and one 4K static memory boards, 16K static memory unpopulated, cassette interface, PROM burner MP-R and software, MPT Timer, two serial and two parallel interface boards. Editor/Assembler, 4K and 8K BASIC, software on ROM and cassette, manuals: $1395. Will ship. Ray Romeu, 2530 Parkway St., Ft. Myers, FL 33901, (813) 936-5459.

FOR SALE: Cardco Universal Cassette Interface for VIC-20 and C-64. In excellent condition: asking $35 or best offer. Also for sale: VIC-20 hardware and cassettes. Will pay shipping. I want to form a VIC-20 users club in the Rochester area. Eduardo Fernandez, 185 Parkside Ave., Rochester, NY 14609, (716) 482-0643.

WANTED: SOL computer modifications: 80- by 24-inch screen module, Z80 module 4 MHz, dual-personality module, and schematic diagram of the IMSAI AP-44 printer. Kjell Qwarnstrom, Lejonets Gata 352, 13660 Handen, Sweden.

FOR SALE: 8080 Editor, Assembler, Monitor in 3 volumes with hex and octal listing and full discussion of their use: $15. 101 Basic Computer Games by Ahl: $6. Basic Software Library, vol.1; $12. $30 for all, postpaid. Also QST and Ham Radio, R. Mendelson, 27 Somerset Place, Murray Hill, NJ 07974.

FOR SALE: North Star Horizon with two DD disk drives, 56K, floating-point board, and Godbout Graphics board. Hazeltine 1500 VDT with 24 by 80 characters. Texas Instruments 810 dot-matrix printer, RS-232C serial interface, 150 cps, 3600 bits per second, tractor feed, and stand. Excellent condition; asking $800 for computer, $300 for terminal, and $700 for printer or make an offer for all. Eddy Stappaerts, 6716 El Rodeo Rd., Rancho Palos Verdes, CA 90272, (213) 377-1682.

FOR SALE: Shugart SA 801R 8-inch SSDD disk drives. All are brand new, still factory-sealed in original cartons. Will sell for $199 each or two for $350. You pay shipping. Greg Olson, POB 908, Newport, WA 99156, (509) 447-5963 evenings and weekends.

FOR SALE: 64K memory board for the Atari 400/800, brand new with guarantee, complete: $85. Ben Katz, 9062 Veronica Dr., Huntington Beach, CA 92646, (714) 968-2780.

FOR SALE: Partially disassembled Harris data terminal (IBM Selectric mechanism, correspondence code, integral modem board, telephone cradle) with IBM and terminal manuals: $125. XITEK SCT-100 (S-100 bus) video board with manual and RF converter: $35 FOB. Richard J. Willis, 10325 Caminito Cuervo #168, San Diego, CA 92108.

FOR SALE: Two printers: Micro Peripherals KP-40 with 44 columns, three 7/8-inch rolls of paper, dot-matrix mechanism and interface; assembled and like new: $75 or best offer. Centronics 737 7 by 9 dot-matrix, six type styles, slightly used condition: $250 or best offer. Thomas Kryst, Rt. 5 Box 209, Rolla, MO 65401.

FOR SALE: Ohio Scientific C3D with 52K bytes main memory, Ampex D80 CRT terminal and Anadex 9501 printer. Disk storage is ¼ megabyte floppy, 7 megabyte disk: $5000. Ellie Miller, Pine Tree Legal Assistance, 146 Middle St., Portland, ME 04101, (207) 774-8211.

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(Required by 39 U.S.C. 3685)

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BYTE

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Unclassified Ads

WANTED: High school student with PET 2001 wants working or broken PETs. I will pay postage. Eric Ryoti, 162 Redwood Dr., Richmond, KY 40475, (606) 623-2207.

FOR SALE: Heath H-11 processor with 32K-byte memory, H-27 dual floppy-disk drive, two serial interface ports, and H-19 CRT. Includes all documentation and FORTRAN/BASIC operating software: $4000 or best offer. T.A. Homan, 7741 Stanley Mill Dr., Centerville, OH 45459, (513) 434-3896.

FOR SALE: RCA VIP with 4K, Simple and Super sound boards, ASCII keyboard, Tiny BASIC, homemade color board, 5 volt, 1A power supply, 3 years, of Viper, and cassettes with over 60 games and programs. With manuals and documentation; requires video monitor and cassette recorder. Over $550 value, selling for $390. Nathan Gopen, 168 Pond St., Sharon, MA 02067, (617) 784-2771.

FOR SALE: Expansion Interface for use with the TRS-80 Model I. I am also interested in 40-track disk drives for use with same. Brad Karp, 8101 Hawthorne Lane, Elkins Park, PA 19117, (215) 379-0667 evenings.

FOR SALE: Heath/Zenith Z-90 with 16K expansion RAM; Z-47 8-inch DSDD drives; H-25 high-speed printer with software: $6500 or best offer. Tim Olson, (701) 774-3684.

FOR SALE: Integral Data Systems Microprism Model 480, 1K-byte buffer, parallel/serial I/O, programmable, graphics, near letter quality, draft speed modes of 5, 6, 8.4, 10, 12, and 16.8 cpi plus other features. Like new with cable and paper: $450. Rich Reis, 711 Copley Lane, Silver Spring, MD 20904, (301) 384-0540.

WANTED: Radio Shack or LNW expansion interface for TRS-80 Model I. Joe Dashiell, 501 Fairfax Rd. #623, Blacksburg, VA 24060, (703) 552-8408.

FOR SALE: TRS-80/S-100. Complete S-100 HUH 8100 bus converter fully loaded. DTE/DCE RS-232C serial, current loop, and parallel I/O. 16K RAM and six S-100 slots, in finished wood case with 8-amp power supply and cooling fan: $600 value, asking $450. Also, two Godbout EconoRAM 8K S-100 at $65 each. Jade Terminator/Extender: $50. Jade Double-D disk-controller kit: $225. Penny Whistle 103 acoustic modem: $50. Will accept reasonable offer. Jens Hansen, (904) 968-0126.

FOR SALE: Three Digital Group machines. Two have TVC64, four parallel and serial ports, keyboard, monitor, and cabinets. One has DG Z80A CPU, 58K, and two drives. Other has R. & W. Z80A CPU, 64K, new motherboards, and two 8-inch DDSS disk drives. Third has DG Z80A CPU, 64K, TVC64, four parallel and serial ports, keyboard, monitor, and two 8-inch DDSS disk drives. Send SASE for list and prices. H. Wood, 2002 Rookwood Rd., Silver Spring, MD 20910, (301) 589-4171.

FOR SALE: HP 82905B Printer. 80-cps impact printer with five type options and graphics. HPIB (IEEE 488) interface, with 2m HPIB cable. New in June '83; $885 retail. $440 or best offer; UPS COD. Also, HPIB cables in different lengths and functional: $30 each ($80-100 retail). Tom von Alten, 9250 Landmark, Boise, ID 83704, (208) 322-7804.

WANTED: Italian-speaking microcomputer fans to exchange ideas and programs for the TI 99/4A home computer. Roy Moglia, 5137 Burlington Ave. N, St. Petersburg, FL 33710.

WANTED: Need to communicate with Morrow Designs Micro Decision users about its good and bad points. Howard Burns, 1265 North Diamond Bar Blvd., Diamond Bar, CA 91765, (714) 594-9259 evenings.

FOR SALE: Serria Data Sciences Z-80 SBC with CP/M 2.2 mounted in XOR 4-slot mainframe with two 8-inch Tandon thinline SSDD drives. Limited use: $1500. D. I. Lawry, POB 1157, Corrales, NM 87048, (505) 898-5245.

FOR SALE: OSI C1P Model II with 8K RAM/ROM, 600 bits per second, cassette interface, joysticks, and software. Documented. Original cost over $600; all for $275 or will trade for Apple II-compatible drive with DOS and controller. Lorenz Huelsbergen, 1908 Alabama St., Lawrence, KS 66044.

BOMB
BYTE's Ongoing Monitor Box

Article #	Page	Article	Author(s)
1	36	Keep Power-Line Pollution Out of Your Computer	Ciarcia
2	48	BYTE West Coast: Microsoft Windows	Lemmons
3	59	User's Column: Buddy, Can You Spare a Door Latch?	Pournelle
4	103	An Introduction to Integrated Software	Chang
5	113	Presentation and Form in User-Interface Architecture	Carroll
6	127	Why Is Software So Hard to Use?	Edwards, Sam
7	143	Walt Disney and User-Oriented Software	Heckel
8	155	Making Life Easier for Professional and Novice Programmers	Pope, Kates, Fineberg
9	161	Simplify, Simplify, Simplify	Dean
10	177	Integrating Voice in the Office World	Nicholson
11	189	The Starburst User Interface	Vandor
12	199	The Complete Information-Management System	Brown
13	210	The Allegory of Software	Houston
14	218	The New Interface Technology	Warfield, White
15	234	Trackball-Interfacing Techniques for Microprocessors	Andrews
16	247	The User Interface: Two Approaches	Herbach, Katz, Landau
17	263	The Future of Metaphor in Man-Computer Systems	Clanton
18	286	The Texas Instruments Professional Computer	Haas
19	329	The ATR8000	Small, Small
20	343	The Hercules Graphics Card	Wadlow
21	360	The Wang Professional Computer	Long
22	372	In Search of the Most Amazing Thing	Holden
23	380	Color Graphics from Any Computer	Essig
24	400	Mainframe to Micro: Adapting a Financial-Modeling Language	Dunn
25	417	POKEing Around in the IBM PC, Part 2: Developing Subroutines for BIOS Interface and Screen-Display Disk Storage	Howson
26	443	The CMOS 6502	Hendrix
27	457	A Tiger Meets a Dragon	Rollins
28	481	A Computer-Algebra-Based Calculating System	Edwards, Stuart
29	519	The User Looks at Books	Pournelle

It May Come as No Surprise

The Circuit Cellar's creator, Steve Ciarcia, has won first place and the $100 bonus in September's roundup with the first part of "Build the Micro D-Cam Solid-State Video Camera," entitled "The IS32 Optic RAM and the Micro D-Cam Hardware." Second place goes to our illustrious commentator, Jerry Pournelle, for "The Next Five Years in Microcomputers." And along with winning the $50 prize for second place, Dr. Pournelle walks off with third place for his User's Column about "Eagles, Text Editors, New Compilers, and Much More." In fourth place, readers chose BYTE technical editor Stanley Wszola for "How to Choose a Portable." And fifth-place winners are the authors of the trilogy entitled "Inside CMOS Technology," Martin B. Pawloski, Tony Moroyan, and Joe Altnether. Congratulations to all these authors.

Correspondence

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Reader Service

Inquiry No.		Page No.
3	1ST.PLACE SYSTEMS	420
1	1 SUPERWAREHOUSE	202
4	800 SOFTWARE	454, 455
6	A.S.T. RESEARCH	279
7	AB COMPUTERS	609
8	ABC DATA PRODUCTS	406
9	ACTION COMPUTER	95
10	ACTION POTENTIAL	604
11	ADDMASTER CORP.	614
12	ADV. COMP. PROD.	638, 639
*	ADV. DIGITAL CORP.	147
14	ADV.GRAPHIC ENGINEERING	604
15	ADV. LOGIC SYSTEMS	307
16	ADV. SYS. CONCEPTS	68
506	AFTERTHOUGHT	642
*	ALF PRODUCTS, INC.	318
18	ALL ELECTRONICS CORP.	538
521	ALPHA NUMERIC	378
20	ALPHA OMEGA COMPUTER	146
26	AM MICRO	268
*	AMDEK CORP.	63
21	AMER. BUYING & EXPORT	534
22	AMER. SQUARE COMP.	83
*	AMERICAN EXPRESS CO.	565
23	ANADEX	435
24	ANGEL'S COMPUTER	485
25	APPARAT INC.	311
27	APPLE COMPUTER INC.	CII, 1
28	APPLE COUNTRY LTD.	624, 625
29	APPLEWARE INC.	600
30	APPLIED SOFTWARE TECH.	323
31	ARKTRONICS CORP.	79
32	ARTIFICIAL INT'L. RESEARCH	614
34	ASHTON-TATE	145
35	ASHTON-TATE	439
36	ATARI SOFT	370, 371
*	AT&T CONSUMER PROD.	309
38	AVIS RENT-A-CAR	571
39	AVOCET	445
40	B&B ELECTR.	600
41	B&B ELECTR.	610
42	BAHR TECHNOLOGY	30
43	BASF SYSTEMS	433
44	BAY TECHNICAL ASSOC.	12
45	BELL, JOHN ENGR.	628
46	BELL, JOHN ENGR.	628
47	BELL, JOHN ENGR.	629
48	BELL, JOHN ENGR.	629
49	BHRT	340, 341
481	BMC USA, INC.	498
482	BMC USA, INC.	498
*	BORLAND, LTD.	456
51	BOTTOM LINE, THE	262
52	BOULDER LOGICAL TESTING	620
53	BROWN DISC MANUFACTURING	176
*	BURDICK CO	446
54	BUSINESS SOLUTIONS	644
*	BYTE PUBL. INC.	494
*	BYTE BACK ISSUES	524
55	BYTEK COMP. SYS. CORP.	466
56	BYTEWRITER	26
*	C WARE	430
57	C-SYSTEMS	614
58	C.S.D. INC.	150
461	CABLES UNLTD.	616
59	CAL-COM SERVICES	608
*	CALIF. DIGITAL	626, 627
60	CALIF. DATA CORP.	600
*	CALIF. MICRO COMP.	316
515	CARRYCASE	280
62	CDR SYSTEMS	616
*	CENTENNIAL COMP. PROD.	259
64	CENTRE COMP.CONSTNTS.	604
65	CENTRE COMP.CONSTNTS.	606
489	CHANNEL SYS	593
66	CHESSELL-ROBOCOM CORP.	94
67	CHIPS & DALE	644
68	CHRISLIN IND. INC.	253
69	CHROMOD ASSOC.	610
72	CLEO	562, 563
73	CMC, INT'L.	24
74	COGITATE	430
75	COGITATE	620
76	COLORADO COMP. PERIPH.	606
77	COLUMBIA DATA PROD.	121
78	COMMAND SERVICES CORP.	600
79	COMMERCIAL BUSINESS SYS.	597
80	COMMUNICATIONS ELECTR.	196, 197
81	COMP. COMPNTS. UNLTD.	634, 635
82	COMP. COMPNTS. UNLTD.	636, 637
487	COMP.WHOLESALERS OF FREDERICK	408
*	COMPAQ COMPUTER CORP.	10, 11
86	COMPETITIVE EDGE	448
495	COMPLEXX SYSTEMS INC.	275
87	COMPONENTS EXPRESS	192
459	COMPU-MEDIA SOFT.	602
88	COMPUADD	612
89	COMPUADD	612
90	COMPUADD	612
91	COMPUADD	612
93	COMPUPRO	149
*	COMPUPRO	540, 541, 542
94	COMPUSERVE	385
95	COMPUSHACK	535
96	COMPUTER ACCESSORIES	291
97	COMPUTER APPARATUS	471
98	COMPUTER CHANNEL	164
99	COMPUTER DISCOUNT PROD.	645
483	COMPUTER EDITYPE	86
477	COMPUTER FOOD PRESS	602
101	COMPUTER FURN. & ACCSS.	207
102	COMPUTER HUT OF N.E.	463
103	COMPUTER INNOVATIONS	106
104	COMPUTER MAIL ORDER	544, 545
514	COMPUTER PAPER PEOPLE	642
*	COMPUTER PLUS	73
106	COMPUTER POST INC.	643
107	COMPUTER PRICE CLUB	606
111	COMPUTER TECHNOLOGY	538
513	COMPUTER TECHNOLOGY	642
*	COMPUTER WAREHOUSE	509
112	COMPUTERLINE INT'L-A	496, 497
113	COMPUTERLINE INT'L-B	298
114	COMPUTERS AND MORE	134
115	COMPUTERS WHOLESALE	325
512	COMPUTRONIX CORP.	642
116	COMPUVIEW PROD.INC.	56, 57
117	CONCORDE PERIPHERAL SYS.	294
118	CONCORDE PERIPHERAL SYS.	294
119	CONDOR COMP. CORP.	303
83	CONROY-LAPOINTE	186, 187
84	CONROY-LAPOINTE	186, 187
85	CONROY-LAPOINTE	186, 187
509	CONTINENTAL PRESS	642
120	CONTROL DATA CORP.	377
121	CONTROL ELECTR.INC.	316
122	CORONA DATA SYS.	337
123	CORVUS SYS. INC.	409
124	COSMOS	165
125	CREATIVE LOGIC	78
126	CREATIVITY UNLTD.	602
127	CROMEMCO	5
128	CUESTA SYSTEMS	612
129	CUMANA	18
130	CUSTOM COMP.TECH.	615
131	DATA ACQUISITIONS SYS.	98, 99
132	DATA STORAGE SOLUTIONS	195
133	DATABASE RESEARCH	179
134	DATAPRODUCTS	515
135	DATASOURCE SYS.MRKTG.	76
504	DATASOUTH COMPUTER CORP.	266
505	DATASOUTH COMPUTER CORP.	426
136	DATEC, INC.	473
137	DECOTEC	608
*	DELUXE COMP. FORMS	410
138	DENNISON KYBE CORP.	293
502	DIALOG	387
139	DIAMOND SFTW.SUPPLY	228
140	DIGICOMP RESRCH CORP	608
141	DIGISOFT COMPUTERS	479
142	DIGITAL DELI	604
143	DIGITAL DIMENSIONS	434
*	DIGITAL EQUIPMENT CORP.	109, 110, 111
144	DIGITAL EQUIPMENT CORP.	415
145	DIGITAL MARKETING	274
146	DIGITAL MEDIA	600
147	DIGITAL RESEARCH	232, 233
148	DIGITAL RESEARCH	547
*	DIGITAL RESEARCH COMP.	603
*	DIRECT SOFTWARE	453
149	DISCOUNT SOFTWARE	267
150	DISCWASHER COMP. ACCESS.	301
151	DISKS 'N THINGS	606
152	DISKWORLD	610
153	DISPLAY TELECOMMNCTNS.	613
154	DISPLAYED VIDEO	607
155	DMA	477
156	DMA SYSTEMS	369
157	DOKAY COMP. PROD. INC.	632, 633
158	DOW JONES SOFTWARE	9
159	DWIGHT CO., INC.	620
160	DYNACOMP	616
161	DYNAX, INC.	167
162	DYSAN CORP.	449
222	EAGLE COMPUTER	528, 529
163	EAGLE SOFTWARE	162
164	EAST SIDE SOFTWARE	347
165	EASTERN ENTERPRISES	172
167	ELCOMP	602
519	ELECTRADE	280
168	ELECTRADE	608
169	ELECTRONIC PROTECTION DEV.	31
170	ELECTRONIC PROTECTION DEV.	33
171	ELECTRONIC SPECIALISTS	448
172	ELEK-TEK	388
488	ELEK-TEK	452
173	ELLIS COMPUTING INC.	69
174	ELLIS COMPUTING INC.	331
*	EMPIRICAL RESEARCH GROUP	122
175	ENGINEERING SPECIALTIES	616
176	ENTER COMPUTER	46, 47
*	EPSON AMERICA	70, 71
179	EPSON AMERICA	555
181	EXCEL	148
182	EXCEL	527
183	EXPOTEK	324
184	EXXON OFFICE SYSTEMS	620
185	F.T.G.DATA SYS.	614
186	FALCO DATA PROD.	142
187	FENWAL PROTECTION SYS.	561
188	FIGURE-LOGIC BUS. EQUIP.	614
189	FLAGSTAFF ENGINEERING	226
190	FLIP-IT	306
191	FLOPPY DISK SERV. INC.	157
192	FORMASTER CORP.	411
193	FORMULA INT'L.	605
194	FORMULA INT'L.	605
195	FOX & GELLER INC.	102
196	FUJITSU PROFESS. MICROSYS.	315
197	GARDEN OF EDEN COMPUTERS	604
*	GENERAL ELECTRIC R&D	480
198	GENERAL TECHNOLOGY	85
199	GIFFORD COMP.SYS.	442
200	GILTRONIX, INC.	620
201	GLOUCESTER COMP.CO.INC.	600
350	GRAY MARKET, THE	599
202	GREAT LAKES COMPUTER	151
204	GREAT SALT LAKE COMP.	617
205	GREAT SALT LAKE COMP.	618, 619
206	GTEK INC.	214
*	H&E COMPUTRONICS	107
207	H&M DISK DRIVE SERVICES	600
493	HANDWELL CORP	431
210	HANDWELL CORP.	611
211	HAYDEN SOFTWARE	269
212	HAYES MICROCOMP.PROD.	139
213	HAYES MICROCOMP.PROD.	447
214	HOLIDAY INNS, INC.	483
215	HOLLYWOOD HARDWARE	620
510	HOLLYWOOD HARDWARE	642
216	HOUSTON INSTRUMENTS	193
217	HUMAN DESIGNED SYSTEMS	231
218	HUMAN SOFT	91
219	I.T.M.	342
220	IBM CORP.	28, 29
223	IMAGE COMP. PROD.	522
224	IN-SYNC	612
225	INCOMM	194
227	INFOCOM	152, 153
228	INFORMATION RESOURCES	470
229	INSIGHT ENTERPRISES	600
230	INT'L COMP.&TELECOMM.INC.	604
231	INTEGRAND	368
232	INTERACTIVE STRUCT.	407
233	INTERCONTN.MICRO SYS.	413
234	INTERDATA SYSTEMS INC.	67
479	INTERFACE INC.	240
480	INTERFACE INC.	240
236	INTERTEC DATA SYS.	13
237	IPF	533
238	IQ TECHNOLOGIES	299
240	J.C. SYSTEMS	129
241	JADE COMP.PROD.	621
242	JADE COMP.PROD.	622, 623
*	JAMECO ELECTR.	105
243	JAMECO ELECTR.	630, 631
244	JDR MICRODEVICES INC.	648, 649
245	JDR MICRODEVICES INC.	650, 651
246	JDR MICRODEVICES INC.	652
247	JUKI INDUSTRY OF AMERICA	201
248	KADAK PRODUCTS	82
249	KAYPRO	548, 549
250	KELLY COMP.SUPPLIES	602
251	KELLY COMP.SUPPLIES	612
252	KELLY COMP.SUPPLIES	620
253	KENSINGTON MICROWARE	339
254	KERN PUBLICATIONS	404, 405
256	KEYTRONICS CORP.	389
257	KING SOFTWARE	600
258	LABORATORY MICROSYS.	82
*	LANGLEY ST. CLAIR	198
259	LANIER BUSN.PROD.	488, 489
260	LANIER BUSN.PROD.	495
262	LEADING EDGE PROD	CIII
263	LIBERTY GROUP INC.	543
264	LIGO RESEARCH INC.	357
*	LINNTON ELECTRONIC SYS.	608
265	LOGICAL DEVICES	14
266	LOGICAL DEVICES	644
267	LOGICAL MICROCOMPUTER	188
268	LOMAS DATA PRODUCTS	246
269	LOTUS DEVELOPMENT	317
270	LSI JAPAN CO.	644
271	LYBEN COMP. SYS.	604
272	LYBEN COMP. SYS.	606
273	LYCO COMPUTER	513
492	MA SYSTEMS	511
274	MACROTECH INT'L.	359
275	MANX SOFTWARE SYS.	62
518	MARITIME SOFTWARE	280
276	MARYMAC INDUSTRIES	522
277	MAYNARD ELECTRONICS	97
278	MC TOY COMPANY	45
*	MC-P APPLICATIONS	333
*	MCGRAW-HILL INC.	304, 305
*	MEMOREX MEDIA PROD.	241
279	MET CHEM INT'L.CORP.	604
280	METHOD SYS.INC.	610
281	METRO COMPUTER	444
282	MFJ ENTERPRISES INC.	222
284	MICRO CRAFT CORP.	383
286	MICRO FOCUS	216, 217
287	MICRO MANAGEMENT SYS.	469
288	MICRO MART	606
289	MICRO MINT	569
290	MICRO MYSTIQUE	606
291	MICRO-TAX	169
283	MICROAGE COMP.STORES INC.	531
497	MICROCOMPUTER SYSTEMS	64
292	MICRODYNAMICS	614
293	MICROHOUSE	215
317	MICROLAND	644
294	MICROMAIL	601
296	MICROPROCESSORS UNLTD.	604
*	MICROSOFT CORP.	88, 89
*	MICROSOFT CORP.	367
*	MICROSOFT CORP.	399
297	MICROTECH EXPORTS	276
298	MICROWARE	224
299	MICROXPRESS	278
300	MID-AMERICA WHOLESALERS	270
511	MILLER, J. W.	642
301	MINI MICRO MART	80, 81
302	MINI MICRO MART	87
303	MINOLTA CORP.	559
*	MK ENTERPRISES	606
304	MORROW	271
305	MOUNTAIN VIEW PRESS	93
306	MPI	423
*	MPS DISTRIBUTORS	208, 209
307	MTI SYSTEMS CORP.	222
*	MUSYS CORP.	255
308	MY SUPPLIER, INC.	616
310	NEC HOME ELECTR.USA	326, 327
312	NEC INFORMATION SYS.	131
313	NELMA DATA	376
*	NETRONICS	418
315	NETWORK CONSULTING INC.	229
316	NETWORK CONSULTING INC.	319
484	NEW AMERICAN LIBRARY	551
*	NORTH HILLS CORP.	378
*	NORTH HILLS CORP.	421
318	NORTH STAR COMPUTERS	265
319	NORTHWEST DIGITAL SYS.	32
320	NOVATION, INC.	174, 175
321	O'HANLON COMP.SYS.	429
322	OCCO	68
323	OCTAGON COMP SYS	140, 141
324	OFFICE NETWORKS CORP.	644
239	OLDEN	44
325	OLIVETTI AND C.SPA	65
326	OLYMPIC SALES	518
328	OMNISOFT	257
*	ORA ELECTRONICS	595
329	ORANGE MICRO	227
330	ORANGE MICRO	272, 273
331	ORANGE MICRO	365
332	ORYX SYSTEMS	552, 553
333	OSBORNE/MCGRAW-HILL	450
*	PACIFIC COMPUTERS	336
334	PACIFIC EXCHANGES	602, 610, 612, 614, 616, 620, 644
498	PACIFIC INFOTECH	108
335	PAN AMERICAN ELEC. INC.	608
494	PANASONIC IND CO.	90
336	PASCOT	74
503	PC NETWORK	537
337	PC WARE INC.	312, 313
339	PEACHTREE SOFTWARE	500
340	PEACHTREE SOFTWARE	501
341	PEACHTREE SOFTWARE	502
342	PEACHTREE SOFTWARE	503
343	PEACHTREE SOFTWARE	505
499	PEGASUS DATA	408
344	PER SCI INC.	614
*	PERCOM DATA	19, 21
485	PHACT ASSOC.	534
345	PHONE I, INC.	86

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Reader Service

Inquiry No.		Page No.
486	PLUM HALL	532
346	PRACTICAL PERIPH.	123, 124, 125
500	PRACTICAL PERIPH.	332
*	PRIMAGES INC.	467
347	PRINCETON GRAPHIC SYS.	296, 297
348	PRINTEK	295
349	PRINTER STORE, THE	116
351	PRIORITY ONE	640, 641
508	PRO MICROSYSTEMS	642
352	PROF.SOFTWARE PROD.	154
353	PROGRAMMERS SOFTWARE EX.	306
*	PROGRAMMING INT'L	260, 261
*	PROGRAMMING INT'L	284, 285
356	PROMETHEUS PRODUCTS	397
357	PURCHASING AGENT, THE	136
358	QUADRAM CORP.	22, 23
359	QUANT SYSTEMS	616
360	QUASAR DATA PROD. INC.	171
361	QUBIE DISTRIBUTING	355
362	QUCES	493
363	QUESTIONAIRE SERVICE CO.	608
475	RADIO SHACK	CIV
*	RANA SYSTEMS	25
388	RANA SYSTEMS	27
367	RANDOM ACCESS INC.	610
368	RHINO ROBOTS INC.	608
*	ROCKY MOUNTAIN MICRO INC.	283
*	ROCKY MT. SOFT. SYS.	348, 349
516	ROGERS LAB	280
369	RTL PROGRAMMING AIDS	522
496	RUTISHAUSER	573
370	RYDEX INDUSTRIES CORP.	474
371	S C DIGITAL	508
372	S-100 DIV. 696 CORP.	92
377	SAFEWARE	192
378	SAGE COMP. TECH.	173
379	SAKATA	249
501	SCIENTIFIC COMPUTER	602
*	SCOTTSDALE SYSTEMS	117
380	SEATTLE COMP.PRODS.	60
381	SEATTLE COMP. PRODS.	507
382	SEEQUA COMP.CORP.	6
383	SEKON COMPUTER	160
384	SELECTONE CORP.COMP.PROD.	610
385	SEMI DISK SYSTEM	137
386	SGL HOMALITE	120
387	SHARP ELECTRONICS	289
366	SIEMENS COMM.SYS.INC.	34, 35
*	SILICON SPECIALTIES	104
389	SLR SYSTEMS	610
390	SLR SYSTEMS	616
391	SOFTLINE CORP.	66
392	SOFTQUEST	118
393	SOFTWARE AUTOMATION	225
394	SOFTWARE BANC	244, 245
396	SOFTWARE BANC DEALER SERV.	119
397	SOFTWARE FASHION	547
*	SOFTWARE GUILD	516, 517
398	SOFTWARE SERVICES	602
490	SOFTWARE SOLUTION	205
*	SORCIM	16, 17
400	SPECTRON INSTRUMENTS	602
401	SPSS	277
402	STAR MICRONICS	126
403	STARBUCK DATA CO.	204
404	STM CORP	163
405	SUNDEX	393
406	SUNNY INT'L.	599
407	SUNTRONICS	597
408	SUPERSOFT	75
409	SUPERSOFT	77
410	SWI INT'L	379
411	SYNETIX	20
412	SYNETIX	328
413	SYSTEM VISION CORP.	160
414	TALLGRASS TECH.	61
415	TATUM LABS	612
416	TAVA CORP.	416
417	TAYCO BUSINESS FORMS	620
427	TDI SYS. INC.	266
418	TDK ELECTRONICS	353
419	TECH STAR LABORATORY	610
*	TEKTRONIX INC.	223
420	TELETEK ENTERPRISES, INC.	55
421	TELETEX COMMUNICATIONS	345
507	TERMINAL DATA	642
422	TERRAPIN INC.	230
423	TEXAS COMP.SYS.	243
424	TEXAS INSTRUMENTS	184
*	TEXAS INSTRUMENTS	440, 441, 465
425	THINKERS SOFT INC.	487
426	THREE M COMPANY	112
428	TIMEX COMPUTER	281
429	TINNEY, ROBERT GRAPHICS	398
*	TINNEY, ROBERT GRAPHICS	550
430	TITAN TECHNOLOGY	422
431	TITAN TECHNOLOGY	438
432	TOPAZ, INC.	221
433	TOSHIBA AMERICA INC.	436
434	TOSHIBA AMERICA INC.	437
435	TRANSACTION STORAGE SYS.	135
436	TRANSTAR	185
437	TRANSTAR	523
438	TRISTAR DATA SYS.	162
*	TRONIX	616
439	TSK ELECTR.CORP.	133
441	U.S. MICRO SALES	646, 647
440	U.S. ROBOTICS	130
442	UNIPRESS SOFTWARE INC.	334
443	UNIVERSAL DATA SYS	58
444	VERBATIM CORP.	183
445	VIDEX	15
446	VIMA	470
447	VISUAL TECH, INC.	351
520	VLM COMPUTER	280
448	VOICE MACHINE COMMUN.	321
449	VOTRAX	521
450	VR DATA	115
451	W.T.I. COMP.&PERIPH.PROD.	425
452	WADSWORTH ELECTR.PUB.CO.	491
453	WANG ELECTR.PUB.INC.	138
*	WANG INSTITUTE	461
*	WANG LABS INC.	557
*	WAREHOUSE SOFTWARE	128
454	WCB COMPUTERS	614
455	WESTERN TELEMATIC	391
*	WESTICO INC.	419
92	WHITAKER, H.L.	644
456	WHITESMITHS LTD	525
457	WILLIAMS, MARK CO.	539
458	WINTEK CORP.	608
460	WORLDWIDE COMP.SUPPLIES	644
517	WRITING CONSULTANTS	280
462	XEROX PRINTING SYSTEMS	566, 567
463	ZAM CONSULTANTS	606

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Ready to Use. Turn on Model 100 and five built-in management programs—plus your own files—are instantly listed on its eight-line by 40-character liquid crystal display. The full-size typewriter keyboard and the powerful editing functions of Model 100's personal word processing program make it a breeze to jot down notes or write letters and reports. Model 100 also works as an appointment calendar, address book, phone directory, plus a telephone auto-dialer. You can even write your own BASIC programs.

A Portable Terminal. With Model 100's communications program and built-in auto-dial modem, you can access national information services, such as CompuServe® and Dow Jones News/Retrieval®. Or connect Model 100 directly to another computer—micro, mini or mainframe—using the RS-232C interface. Model 100 also includes a parallel printer port and a cassette tape interface.

Available Nationwide. You don't have to go out of your way to buy this gift! You can get the 8K Model 100 (Cat. No. 26-3801, $799) or the 24K Model 100 (26-3802, $999) at any Radio Shack Computer Center, participating store or dealer near you.

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